

Sokoine University of Agriculture



PhD Thesis

**Development And Rapid Assessment Of
Community Based Health Educational
Package For Control Of *Taenia Solium*
Cysticercosis/Taeniasis In Tanzania**

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May, 2024

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Educational Package for Control of *Taenia Solium*
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***Thesis submitted to Sokoine University of Agriculture in
Fulfilment of the Requirements for the Degree of Doctor
of Philosophy***

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EXTENDED ABSTRACT

Taenia solium taeniasis/cysticercosis is a neglected parasitic zoonosis with significant economic and public health impacts worldwide. Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization ranked it first on the global scale of food-borne parasites. *Taenia solium* cysticercosis/taeniasis (TSCT) impacts is more in developing countries, including Tanzania, where social, economic, and cultural conditions favour its endemicity. Community knowledge is central in successful disease control in endemic areas. For control intervention to be effective and sustainable it should engage the community from planning stage. The study addressed the gap on knowledge, attitude and practices related to the disease, developed and conducted rapid assessment of a community-based health educational package (CHEP) for the prevention and control of TSCT in Tanzania. The study employed a community-based mixed methods approach involving different qualitative and quantitative approaches, using questionnaire for the household survey from 483 selected households, in addition, household infrastructure observations were conducted to the same 483 randomly selected households, Focused Group Discussions (FGD) and Key Informants Interviews (KII) were also conducted in Mbulu, Rungwe, Mbinga and Mwapwa districts. The information collected led to the formulation of key messages for the development of a health education package, which comprises four components including; a training manual for the training of trainers (TOTs), a booklet with illustrations and instructions on how to perform small doable actions, brochure with key messages and poster with a tapeworm life cycle indicating the areas which can be targeted to interrupt the transmission. The formative research method was used in the development of the package. It is expected that the CHEP will be sustainable as its development engaged the community in all stages of development.

The CHEP developed was assessed in Babati district. This was done to assess the effectiveness of the package towards improvement of community knowledge attitude and practices towards control of TSCT. Qualitative data were analysed using thematic analysis. Descriptive statistics and chi-square test were used to analyse quantitative data including data on knowledge, attitude, and practices. Binary logistic regression was used to examine factors influencing socio demographic factors on knowledge and related practices, both independent and dependent variables were used. Socio demographic factors assessed were sex, age, district/location, education level, age group, main source of income, period of residence in years, and Savings and Credit Cooperative Society. The results revealed good knowledge about porcine cysticercosis, particularly among pig keepers across the districts. Majority of participants (48%) had heard about the pork tapeworm and the knowledge about clinical signs/symptoms and treatment was fair, but the means of transmission and prevention measures were often unknown. The risk perception of the infection with the pork tapeworm was low too and a similar trend is reflected in the attitudes toward the low-risk perception of cysticercosis infection. Hand washing practices was also low, many participants reported not washing their hands before eating or after using the

toilet which highlights potential risks for the transmission of human cysticercosis. Almost all participants reported using the toilet always, however, household observations revealed that toilets were either lacking or had no complete walls, with others showing the sign of not being used for some time. Generally, household observations revealed a discrepancy between responses to the questionnaire on one hand and the availability of toilet and handwashing facilities, and the confinement of pigs on the other hand. This highlights the importance of including household observation during data collection. Respondents with tertiary education were more likely to have heard of tapeworm, be aware of *T. solium* transmission, be aware of *T. solium* health effects, and be aware of human cysticercosis transmission. Male respondents were more likely to be knowledgeable about porcine cysticercosis transmission. Lack of standardised education materials about the disease might influence the quality of health education in different infected communities. Using the gathered information, the health education package on knowledge, attitude, and practices reported a statistically significant improvement in knowledge regarding the link between epilepsy and cysticercosis and in the practice of washing fruits and vegetables, however, the long-term effect of the health educational package on knowledge, attitude, and practices and the disease parameter need to be evaluated. This study has revealed poor knowledge of *T. solium* Cysticercosis/Taeniasis with generally better knowledge about its effects on porcine than on human health. The limited overall knowledge, together with negative attitudes and practices may represent an important barrier to TSCT control and elimination efforts. It is therefore recommended to scale up the efforts of knowledge sharing with the general population on transmission, TSCT clinical signs/symptoms, control, treatment, and prevention in Tanzania, preferably adopting one health approach, to improve favourable knowledge, attitude for control and eventual eradication of TSCT. The study shows that socio-demographic factors have a direct influence on knowledge and practices related to TSCT. Education was the most important factor among the others and contributed significantly to the overall models that determined knowledge and practices related to TSCT. It is therefore, recommended that studies that include health education interventions also consider socio-demographic factors. Another area covered by this study was the development and rapid assessment of the health educational package which revealed an improvement in knowledge regarding tapeworm treatment from 61 (81.3%) pre-intervention to 76 (95.0%) post-intervention, while the knowledge regarding condemnation of infected pork increases from 65 (83.3%) pre-intervention to 73 (90.1%) post-intervention. Practices about washing vegetables and fruits significantly improved ($P=0.025$), while, that of pigs' confinement increased from 45 (77.6%) pre-intervention to 54 (88.5%) post-intervention. It is recommended that to achieve the maximum impact of the intervention, the educational package should be combined with other existing control strategies as well as other intervention methods such as video, cartoons for school children, and a computer-based health-education tool such as the vicious worm. It is also recommended that the interventions preventing TSCT reinfection, such as improvements in hygiene achieved through health education, are urgently required to augment the effect of other control strategies as part of an integrated approach.

IKISIRI KUU

Mnyoo wa tegu wa nguruwe (*Taenia solium* taeniasis/cysticercosis) ni miongoni mwa magonjwa yasiyipewa kipaumbele na yenye athari kubwa za kiuchumi na afya ya umma duniani kote. Shirika la Chakula na Kilimo la Umoja wa Mataifa (FAO) na Shirika la Afya Duniani (WHO) liliweka nafasi ya kwanza kwenye kiwango cha kimataifa cha vimelea (parasites) vinavyoenezwa na chakula. Minyoo tegu (Tapeworm/*T. solium*) ni tatizo kubwa la kiafya na kiuchumi katika nchi zinazoendelea, ikiwemo Tanzania, ambapo hali ya kijamii, kiuchumi na kiutamaduni inapelekea kuwepo kwa tatizo hilo. Uelewa wa jamii ni muhimu katika udhibiti wa magonjwa kwa katika maeneo yenye maambukizi makubwa. Ili udhibiti wake uwe mzuri na endelevu unapaswa kuhusisha jamii kuanzia hatua ya kupanga hadi utekelezaji na ufuatiliaji. Utafiti huu uliwezesha kutambua mapungufu yaliyopo kwa jamii juu ya maarifa, mtazamo na mazoea kuhusiana na ugonjwa huo. Utafiti huu ulitengeneza na kufanya tathmini ya haraka ya bando kitita la elimu ya afya ya jamii (health education package) kwa ajili ya kuzuia na kudhibiti ugonjwa wa minyoo tegu (Tapeworm/*T. solium*) nchini Tanzania. Utafiti ulitumia mbinu mchanganyiko zilizohusisha ukusanyaji takwimu, kwa kutumia dodoso la utafiti wa kaya kutoka kaya 483 zilizochaguliwa, aidha, uchunguzi wa miundombinu ya kaya ulifanyika kwa kaya 483 zilizochaguliwa kwa kufuata taratibu za kitafiti. Pia majadiliano ya vikundi lengwa (FGD) na usaili wa watoa taarifa muhimu (KII) pia ulifanyika katika wilaya nne za Mbulu, Rungwe, Mbinga na Mpwapwa. Taarifa zilizokusanywa zilipelekea uundaji wa ujumbe muhimu kwa ajili ya matengenezo ya bando kitita la elimu ya afya, ambalo linajumuisha vitu vinne ikiwa ni pamoja na; mwongozo wa mafunzo kwa wakufunzi (TOTs), kijitabu chenye vielelezo na maelekezo ya jinsi ya kufanya vitendo vidogo vinavyoweza kutekelezeka, kipeperushi chenye ujumbe muhimu na bango lenye mzunguko wa maisha ya minyoo ya tegu. Inatarajiwa kuwa bando kitita hili la elimu ya afya litakuwa endelevu kwani ni utengenezwaji wake ulishirikisha jamii katika hatua zote.

Bando kitita la elimu ya afya lilioandaliwa lilifanyiwa tathmini ya muda mfupi wilayani Babati. Hili lilifanywa ili kutathmini ufanisi wa bando kitita hilo kuelekea uboreshaji wa maarifa, mtazamo na mazoea ya jamii kuelekea udhibiti wa minyoo tegu ya nguruwe (Tapeworm/*Taenia solium*). Taarifa za uchakati wa takwimu zilizokusanywa toka wilaya hizo nne yalionyesha uelewa mzuri kuhusu tegu wa nyama ya nguruwe (porcine cysticercosis), hasa miongoni mwa wafugaji wa nguruwe katika wilaya zote nne. Miongoni mwa washiriki (48%) walikuwa wamesikia kuhusu minyoo tegu ya nguruwe na uelewa kuhusu ishara/dalili na matibabu ulikuwa wa kuridhisha, lakini njia za maambukizi na za kuzuia hazikuwa zikijulikana toka kwa washiriki wengi. Mtazamo juu ya wanajamii kuwa kwenye hatari ya kuambukizwa minyoo ya nguruwe ulikuwa mdogo na mwelekeo kama huo ulionekana katika mitazamo yao midogo juu ya kuwa kwenye hatari ya maambukizi ya tegu wa nyama ya nguruwe (porcine cysticercosis). Mbinu sahihi za kunawa mikono pia zilikuwa

za chini, washiriki wengi waliripoti kutonawa mikono kabla ya kula au baada ya kutoka chooni jambo ambalo linaonyesha hatari zinazoweza kutokea za maambukizi ya tegu wa nyama ya nguruwe kwa binadamu (human cysticercosis). Takriban washiriki wote waliripoti kutumia choo kila mara, hata hivyo, uchunguzi wa kaya ulibaini kuwa vyoo vilikuwa havina au havikuwa na kuta kamili, huku vingine vikionyesha dalili ya kutotumika kwa muda. Kwa ujumla, uchunguzi wa kaya ulidhihirisha tofauti kati ya majibu ya dodoso kwa upande mmoja na upatikanaji wa vyoo na vifaa vya kunawa mikono, na kufunguwa kwa nguruwe mabandani kwa upande mwingine. Hii inadhihirisha umuhimu wa kujumuisha uchunguzi wa kaya wakati wa kukusanya takwimu. Wahojiwa waliokuwa na kiwango cha elimu ya juu walionyesha uwezekano mkubwa wa kuwahi kusikia kuhusu minyoo tegu ya nguruwe, kufahamu kuhusu maambukizi ya minyoo tegu (Tape worm/*T. Solium*), kufahamu kuhusu athari za kiafya afya za minyoo tegu (Tape worm/*T. solium*) kwa binadamu, na kuwa na ufahamu wa maambukizi ya tegu wa nyama ya nguruwe kwa binadamu (human cysticercosis). Wanaume walioshiriki kujibu dodoso walikuwa na uelewa mkubwa kuhusu maambukizi ya tegu wa nyama ya nguruwe (porcine cysticercosis). Kwa kutumia taarifa zilizokusanywa, bando kitita la elimu ya afya (health education package) liliripoti uboreshaji mkubwa wa kitakwimu wa uelewa wa wanajamii kuhusu uhusiano uliopo kati ya kifafa na tegu wa nyama ya nguruwe na katika umuhimu wa tabia za kuosha matunda na mboga mboga, hata hivyo, manufaa ya muda mrefu ya bando kitita la elimu ya afya kuhusu maarifa, mtazamo, na mazoea yanahitaji kutathminiwa. Utafiti huu umefichua maarifa duni kuhusu Minyoo tegu (Tapeworm/*T. solium*) ingawa maarifa yalikuwa ya zaidi kuhusu madhara yake kwa nguruwe kuliko madhara yake kwa afya ya binadamu. Maarifa madogo ya jumla, pamoja na mitazamo na mazoea hasi yanaweza kuwa kikwazo muhimu katika juhudi za kuthibiti na kuondoa minyoo tegu (Tapeworm/*T. solium*). Kwa hiyo inashauriwa kuongeza juhudi za kuilemimisha jamii kuhusu maambukizi, ishara/dalili za minyoo tegu (Tapeworm/*T. solium*), udhibiti, matibabu, na kinga nchini Tanzania, ikiwezekana katika mkabala mmoja wa afya (one health approach), ili kuboresha maarifa na mtazamo unaofaa kwa udhibiti na hatimaye kutokomeza minyoo tegu (Tapeworm/*T. solium*). Utafiti huu umeonyesha kuwa masuala ya idadi ya watu kijamii (**socio-demographic factors**) yana ushawishi wa moja kwa moja kwenye maarifa na tabia za kimazoea zanzohusiana na minyoo tegu (Tapeworm/*T. solium*). Elimu ilikuwa jambo muhimu zaidi miongoni mwa mengineyo lililochangia kwa kiasi kikubwa juu ya uelewa wa jumla kuhusu minyoo tegu (Tapeworm/*T. solium*). Kwa hivyo inashauriwa kuwa tafiti zinazojumuisha mipango ya elimu ya afya zizingatie pia vipengele vya idadi ya watu kijamii. Eneo lingine lililoshughulikiwa na utafiti huu lilikuwa ni kufanya tathmini ya haraka ya bando kitita la elimu ya afya. Inapendekezwa kwamba ili kufikia mafanikio makubwa katika kuthibiti tatizo hili la minyoo tegu, bando kitita la elimu ya afya linapaswa kuunganishwa na mikakati mingine iliyopo ya udhibiti pamoja na njia zingine kama vile video, katuni za watoto wa shule, na zana ya elimu ya afya inayotegemea kompyuta.

Inapendekezwa pia kwamba hatua zinazozuia minyoo tegu (*Tapeworm/T. solium*) kuambukizwa tena, kama vile uboreshaji wa usafi kupitia elimu ya afya, zinahitajika kwa haraka ili kuongeza mafanikio kwa kuhusisha mikakati mingine ya udhibiti kama sehemu ya mbinu jumuishi.

DECLARATION

I, CHACHA JOSEPH NYANGI, do hereby declare to the Senate of Sokoine University of Agriculture that this thesis is my own original work, done within the period of registration and that it has neither been submitted nor being currently submitted in any other institution.

Chacha Joseph Nyangi
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Date

The above declaration is confirmed by:

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Lastly, I wish to declare to all those who have assisted me in this work that I am fully responsible for any errors, omissions or short comings therein and that they are not accountable for any imperfection which may appear in this thesis.

DEDICATION

I dedicate this work to my lovely Wife Blanka B. Minja, you have travelled countless times between Mbeya and Morogoro to make sure I'm always comfortable; you have made this journey possible.

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LIST OF ACRONYMS AND ABBREVIATIONS

Ab-ELISA	Antibody Enzyme-Linked Immunosorbent Assay
Ag-ELISA	Antigen Enzyme-Linked Immunosorbent Assay
BMBF	German Federal Ministry of Education and Research
BOD	Burden of Disease
CHEP	Community Based Health Education Package
CDC	Center for Disease Control
CICT	Centre for Information and Communication on echnology
CYSTINET-Africa	Cysticercosis Network of Sub-Saharan Africa
DALYs	Disability Adjusted Life Years
DCDO	District Community Development Officer
DEO	District Education Officer
ELISA	Enzyme-Linked Immunosorbent Assay
ESA	Eastern and Southern Africa
ESNCC	Epilepsy Secondary to Neurocysticercosis
FAO	Food and Agriculture Organisation
FGD	Focus Group Discussion
GBD	Global Burden of Disease
HBM	Health Behaviour Model
HCC	Human Cysticercosis
HEI	Health Education Intervention
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome
IBM	Integrated Behavioural Model
KAP	Knowledge, Attitude and Practices
KII	Key Informants Interview
LFO	Livestock Field Officer
LMIC	Lower and Medium Income Countries
NCC	Neuro Cysticercosis
NIMRI	National Institute for Medical Research
NTD	Neglected Tropical Diseases
OIE	World Organisation for Animal Health
OR	Odds Ratio
PCC	Porcine Cysticercosis
PRECEDE-PROCEED	Predisposing, Reinforcing, and Enabling Constructs in Educational/Environmental Diagnosis and Evaluation - Policy, Regulatory, and Organizational Constructs in Educational and Environmental Development
PWE	People With Epilepsy
PWOE	People Without Epilepsy

SACCOS	Savings and Credit Cooperative Society
SAS	Statistical Analysis System
SDA	Small Doable Action
SODIS	Solar Disinfection
SPSS	Statistical Package for Social Sciences
SSA	Saharan Sub Africa
TOTs	Training of Trainers
TPB	Theory of Planned Behaviour
TRA	Theory of Reasonable Action
TSCT	<i>Taenia Solium</i> Cysticercosis Taeniasis
TUM	Technical University Munich
URT	United Republic of Tanzania
USD	United State Dollar
VHC	Village Health Committee
VIP	Ventilated Improved Pit Latrine
WASH	Water Sanitation and Hygiene
WHO	World Health Organisation
YLD	Years of Healthy Life Lost Due to Specific Illness or Disability
YLL	Years of Life Lost Due to Death

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Taenia solium taeniasis/cysticercosis (TSCT) is a neglected parasitic zoonosis with significant economic and public health impacts (WHO, 2015a). Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO) ranked it first on the global scale of food-borne parasites (FAO and WHO, 2014). It occurs more frequently in countries with low socio-economic development (Murrell *et al.*, 2005), and in particular with poor standards of personal hygiene, poor environmental sanitation with inadequate disposal or containment of human stool, poor pig management practices with the well-known rate of free-roaming pigs, non-existence of poor meat inspection, lack of control measures at all levels of the market chain, poor knowledge on the method of transmission of *Taenia solium*, climatic conditions (warm or temperate) and by the lack of health education in the population (Phiri *et al.*, 2003; Sikasunge *et al.*, 2007; Ngowi *et al.*, 2008; Mwanjali *et al.*, 2013).

TSCT results in two distinct diseases: cysticercosis and taeniasis (WHO, 2015a). Taeniasis is the intestinal infection with adult tapeworms, while cysticercosis is the development of larval cysts in the tissues, eyes, and brain of humans (García *et al.*, 2002; Carabin *et al.*, 2011; WHO, 2015a). Neurocysticercosis (NCC) is the infestation of cysticerci in the central nervous system, which may lead to epilepsy (WHO, 2015a). This is a preventable disease that can be eradicated, and is estimated to cause between 30% and 50% of epilepsy cases in Ethiopia, Tanzania, and the rest of SSA (Winkler *et al.*, 2008; Winkler, *et al.*, 2009; Winkler, 2012; Femi *et al.*, 2020).

Taenia solium is suspected to be existing in all Sub-Saharan Africa (SSA) countries with a prevalence of Porcine cysticercosis (PCC) with a range of up to over 50% (Assana *et al.*, 2013; Murrell *et al.*, 2005; Okello and Thomas, 2017; Phiri *et al.*, 2003; Shonyela *et al.*, 2017). Previous studies report human *T. solium* taeniasis in SSA with a prevalence between 0% and 13.9%, and human cysticercosis prevalence between 1.3% and 45.3% (Coral-Almeida *et al.*, 2014; Mwanjali *et al.*, 2013; Shonyela *et al.*, 2017). The main reason for the high prevalence is the lack of health education in the community on the TSCT complex as the key to control and eradication (Ngowi *et al.*, 2008; Shonyela *et al.*, 2017). The major causal factors of the disease occurrence were free-roaming pigs and poor sanitary conditions (Shonyela *et al.*, 2017).

The WHO Constitution of 1948 defines health as a state of complete physical, social and mental well-being, and not just the non-appearance of

disease or illness. Health education is defined as a process containing deliberately created opportunities for education and communication intended to improve health information, health literacy, and health knowledge and develop life skills that are advantageous to the promotion of an individual and community's health including that of the environment (WHO, 2012).

Community health education plays an important role in the way to control/eliminate *T. solium* cysticercosis and taeniasis (TSCT). Besides, sustainable disease control in resource-poor countries requires low-cost interventions. The main objective of this study was to develop and carry out a rapid assessment of the community-based health educational package (CHEP) for control of TSCT in Tanzania.

1.2 Problem Statement and Study Justification

1.2.1 Problem statement

Taenia solium cysticercosis/taeniasis is an important health and economic problem in developing countries, including Tanzania, where social, economic, and cultural conditions favour its endemicity. The estimated prevalence of porcine cysticercosis Africa is 24.3%, and of human taeniosis/cysticercosis is 37.3% (Shonyela *et al.*, 2018). The prevalence of PCC has been reported in most SSA countries with a range of up to over 50% (Assana *et al.*, 2013; Okello and Thomas, 2017; Phiri *et al.*, 2003). The prevalence of taeniasis in Tanzania was reported to range from 0.4% to 5.2% (Eom *et al.*, 2011; Mwanjali *et al.*, 2013), while that of porcine cysticercosis was found to range from 1.5% to 33.3% (Ngowi *et al.*, 2008). Furthermore, a study from Tanzania reported a high prevalence of human epilepsy in PCC endemic areas associated with neurocysticercosis (Ngowi *et al.*, 2004). Currently, TSCT affects more than 50 million people, causing the death of about 50 000 people each year around the world (WHO, 2013). Epilepsy accounts for over 13 million disability-adjusted life years (DALYs) and is responsible for more than 0.5% of the global burden of disease (GBD). It affects people of all ages, sexes, races, income groups, and geographical locations. Around 7.6 per 1000 persons have epilepsy during their lifetime (WHO, 2019). There is a higher incidence of epilepsy in LMICs (139 per 100 000 person-years) compared to high-income countries (HIC) (48.9%) (WHO, 2019). Approximately one-third of epilepsies cases in some LMICs where the *T. solium* (pork tapeworm) is endemic, roughly are attributed to neurocysticercosis (WHO, 2019). In Tanzania, there are limited studies conducted to evaluate the impact of health education in controlling TSCT and reported an increase in knowledge and reduction of PCC incidences (Mwidunda *et al.*, 2015; Ngowi *et al.*, 2011). One of the studies observed minimal change in the behaviour of participating communities about TSCT transmission (Ngowi *et al.*, 2008). The main objective of this study was, therefore, to develop and rapidly assess a community-based health educational package (HEP) for the control of TSCT in Tanzania.

1.2.2 Justification of the study

Studies across the globe indicate that health education intervention is important in the prevention and control of infectious diseases (Sarti *et al.*, 1997; Ngowi *et al.*, 2008, 2011, 2017; Alexander *et al.*, 2012; Mwidunda *et al.*, 2015;). However, to be effective and sustainable, health education intervention should fully engage targeted communities in all stages (Sarti *et al.*, 1997; Alexander *et al.*, 2012;) and then be incorporated into routine educational systems and political forums to enhance sustainability.

This study is useful in terms of knowledge contribution in the control of TSCT as well as its role toward improving smallholder pig-keeping farmers' KAP (Ngowi *et al.*, 2008, 2011, 2017, Nyangi *et al.*, 2022).

The study is useful for achieving the UN Sustainable Development Goals (SDGs) (WHO, 2021a) through an integrated approach for the control strategies. There is a consensus among scientists that a combination of different intervention strategies, including veterinary and medical services as well as other health-related scientists, in this case, can join forces and follow the multi-sectorial One Health approach as the best approach towards control of TSCT (Gonzalez *et al.*, 2003; García *et al.*, 2007; Braae, *et al.*, 2015; Okello and Thomas, 2017; Ramiandrasoa *et al.*, 2020). It has been reported that successful long-term change will occur only if the intervention programs are associated with community participation and health education interventions (Sarti *et al.*, 1997; Alexander *et al.*, 2012; Dewey *et al.*, 2013; Mwidunda *et al.*, 2015; Ngowi *et al.*, 2017).

The study is also useful in achieving a national health policy on NTD that promotes public awareness of NTDs, increased access to care for people already affected with NTD morbidity, enhanced NTD management systems, monitoring, and evaluation, and strengthened operational research and surveillance capacity for early detection of NTDs and any recurrence (URT, 2017). The policy also addresses issues related to Water, Sanitation, Food Safety, and Hygiene, which government declared that there are several challenges including the absence of improved latrines, inadequate management of waste, inadequate capacity and resources to provide and sustain safe water, and food, sanitation, and hygiene services at households and public places (URT, 2017).

1.3 Study Objectives

1.3.1 Overall objective and hypothesis

The overall objective of the research project was to develop and assess a community-based health educational package for the control of TSCT in Tanzania and determine the influence of the developed health educational

package on the communities' knowledge, attitude, and practices (KAP) and changed behaviour for the aim of improved control of TSCT.

The hypothesis tested was: A community-based health educational package targeting TSCT can increase the community's knowledge and influence their attitudes and practices about transmission, symptoms, health effects, treatment, and prevention, thus leading to behaviour change. The hypothesis was tested using the specific objectives below.

1.3.2 Specific objectives:

1. To assess the community's Knowledge, Attitude, and Practices (KAP) in control of TSCT;
2. To assess socio-demographic factors influencing knowledge and practice regarding TSCT;
3. To develop and carry out a rapid assessment of a ready-to-use community-based health education package for controlling TSCT in Tanzania;

1.4 Theoretical Framework

A well thought and selected combination of models may result in more robust interventions than interventions developed without models (Legler *et al.*, 2002; Ammerman *et al.*, 2002), because the models tend to complement each other in describing the studied phenomenon. Research or practice in health promotion and education cannot be dominated by a single model, researchers tend to combine or blend theories. However, the weakness of combining theories is the practical limit of how many models can be combined and applied in any single study (Champion and Skinner, 2008). If appropriate constructs in the models are not measured or are not measured well, it may not be possible to understand how an intervention utilised its impact.

1.4.1 PRECEDE-PROCEED model

This study employ the Predisposing PRECEDE-PROCEED (Fig. 1.1) model to guide it. PRECEDE stands for 'Predisposing, Reinforcing, and Enabling Constructs in Educational/Environmental Diagnosis and Evaluation' while PROCEED stands for Policy, Regulatory, and Organisational Constructs in Educational and Environmental Development (Gielen *et al.*, 2008). The PRECEDE-PROCEED model' has been used successfully in various TSCT control programs to assist health education and behaviour change by distinguishing the roles of individuals, communities, and outside influences on TSCT infection (Ngowi *et al.*, 2009; Champion and Skinner, 2008; Ngowi *et al.*, 2017).

The focus of this model is to provide a framework for planning and evaluating health behaviour change programs (Gielen *et al.*, 2008). PRECEDE-

PROCEED can be considered as a *road map* and behaviour change theories as the exact *directions* to a destination, the road map shows all the possible paths, whereas the model proposes certain paths to follow (Gielen *et al.*, 2008). The main purpose is to provide a structure for applying theories and concepts systematically for planning and assessing the change in health behaviour programs (Gielen *et al.*, 2008).

This model was significant when designing this study, as its method addresses the concern that health education emphasises too much on program implementation, with little emphasis on program-designing interventions that are deliberately planned to meet proven needs (Bartholomew *et al.*, 2006). For this purpose, the study adopted part of the model during the development of the CHEP, mostly phase 1 to phase 4. The fundamental principle in this model is participation, which states that success in attaining change is improved by the vigorous participation of the intended audience in describing their high-priority problems and goals and in developing and implementing solutions (Gielen *et al.*, 2008). Since the gap in the community was identified, it was necessary to employ a planning model like PRECEDE-PROCEED, which has been a basis of health promotion practice for decades, and that can help guide this process and fix the problem (Gielen *et al.*, 2008).

Much focus of this study was on developing a ready-to-use community-based health educational package that will meet the target community's needs. Thus, it was necessary to consult the model, as the model relies on its principle of targeting the health education intervention to changeable factors, that are most important and that predispose people to behaviours/practices instead of targeting the behaviours directly (Gielen *et al.*, 2008).

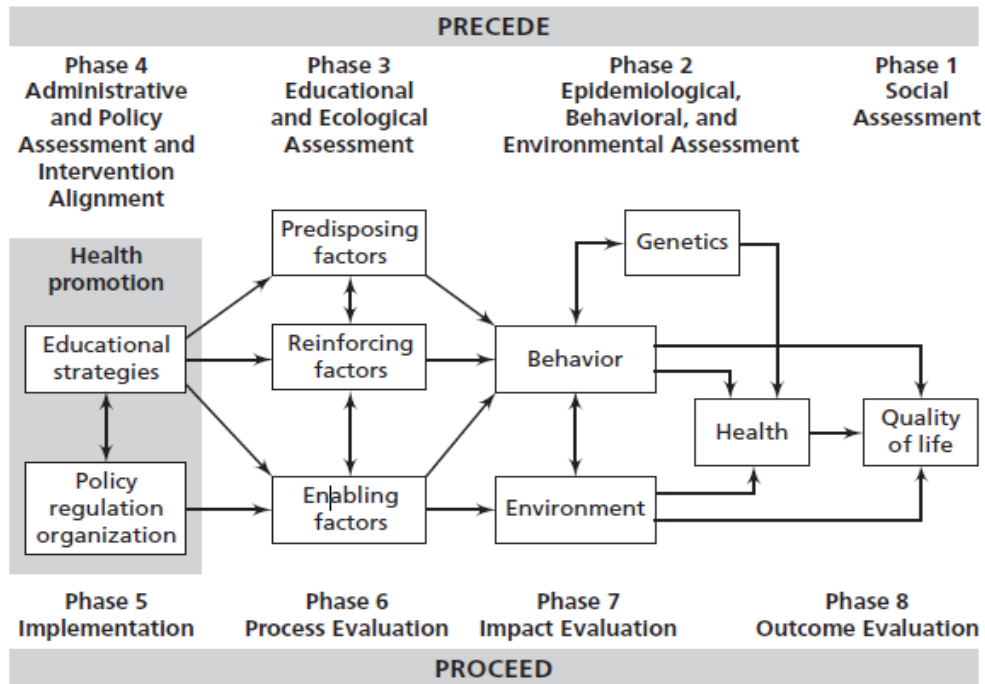


Figure 1.1: PRECEDE-PROCEED model (Gielen *et al.*, 2008).

1.4.2 An integrated behavioural model (IBM)

An integrated behavioural model (Fig. 1.2) is recommended as it includes constructs from the Theory of Reasoned Action (TRA); Theory of Planned Behaviour (TPB); Health Behaviour model (HBM) and rational (KAP) theory, as well as from other influential theories. Rational (KAP) theory demonstrated that knowledge is not a sufficient but important factor in changing individual or collective behaviour (Montaño and Kasprzyk, 2008).

The most important determinant of behaviour in IBM as it is in TRA and TPB is an intention to perform the behaviour. Without intention, a person is unlikely to perform a recommended behaviour (Montaño and Kasprzyk, 2008). The application of IBM to understand a particular behaviour will recognise underlying beliefs that determine one's attitude, perceived norm, perceived control, and self-efficacy, and affect the possibility of carrying out the behaviour (Montaño and Kasprzyk, 2008). This model is lacking principles of participation and that of targeting the health education intervention to changeable that predisposes people to behaviours/practices instead of targeting the behaviours directly. To complement this, we had to employ another model known as the PRECEDE-PROCEED model, which is based on its fundamental principle of participation.

The IBM is appealing because it incorporates intra-individual factors, including self-efficacy, as well as environmental factors known to influence health behaviours (Montaño and Kasprzyk, 2008).

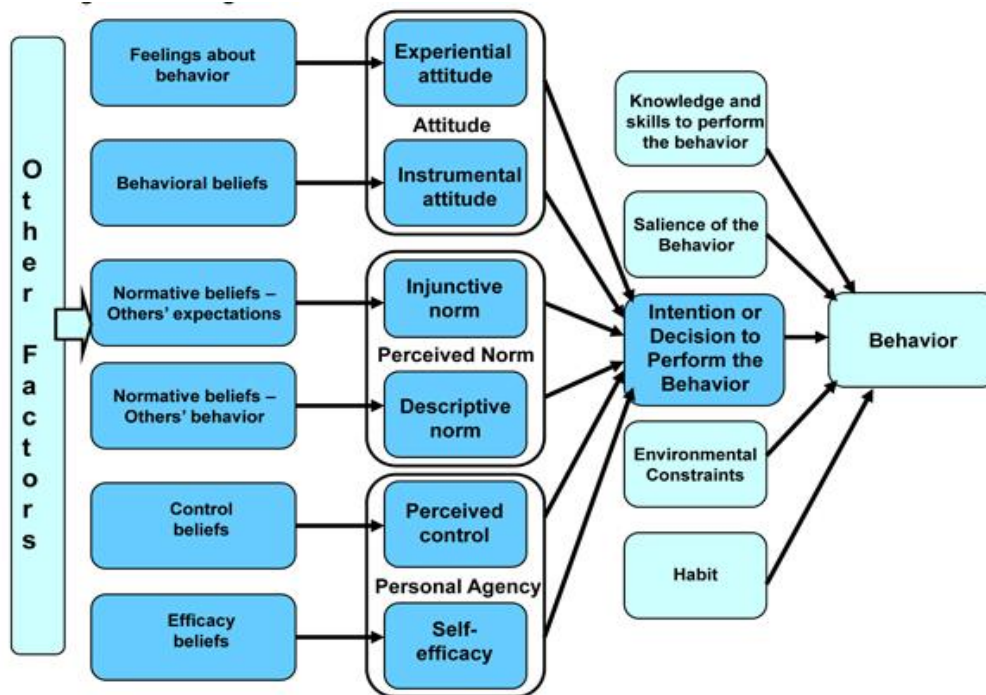


Figure 1.2: Integrated Behaviour Model (Montaño and Kasprzyk, 2008)

1.4.3 Health Belief Model

The HBM (Fig.1.3) contains several primary concepts that predict why people will take action to prevent, screen for, or control illness conditions; these include susceptibility, seriousness, benefits, barriers to behaviour, cues to action, and most recently, self-efficacy (Champion and Skinner, 2008). If individuals regard themselves as susceptible to a condition, believe that condition would have potentially serious consequences, believe that a course of action available to them would be beneficial in reducing either their susceptibility to or severity of the condition and believe the expected benefits of taking action outweigh the barriers to (or costs of) action, they are likely to take action that they believe will reduce their risks (Champion and Skinner, 2008).

The HBM has been used extensively to determine relationships between health beliefs and health behaviours, as well as to inform interventions. Its simplicity has enabled researchers to recognise significant theories, thus increasing the likelihood that a theoretical base will be used to structure the research interventions. Its simplicity, however, also creates some of its major limitations and several challenges remain when considering the HBM as a model to predict health-related behaviours. The Health Belief Model comprises several primary concepts that forecast why individuals act to prevent or control diseases (Champion and Skinner, 2008). These include the following concepts: -

- a) *Perceived susceptibility*: refers to belief about the probability of experiencing a risk of getting a condition or disease;

- b) *Perceived severity*: feeling about the seriousness of getting an illness and the seriousness of a condition and its consequences if left untreated;
- c) *Perceived benefits*: Beliefs in the effectiveness of the recommended measures taken to minimise the risk or seriousness of the disease impact;
- d) *Perceived barriers*: opinions regarding the material and emotional costs of taking action;
- e) *Cues to action*: Approaches to activate “readiness” to take action change, such as providing the information and using appropriate reminder systems;
- f) *Self-efficacy*: confidence in one’s ability to take action it is a conviction that one can successfully change the behaviour required to produce the outcomes” (Bandura and Locke, 2003; Champion and Skinner, 2008);

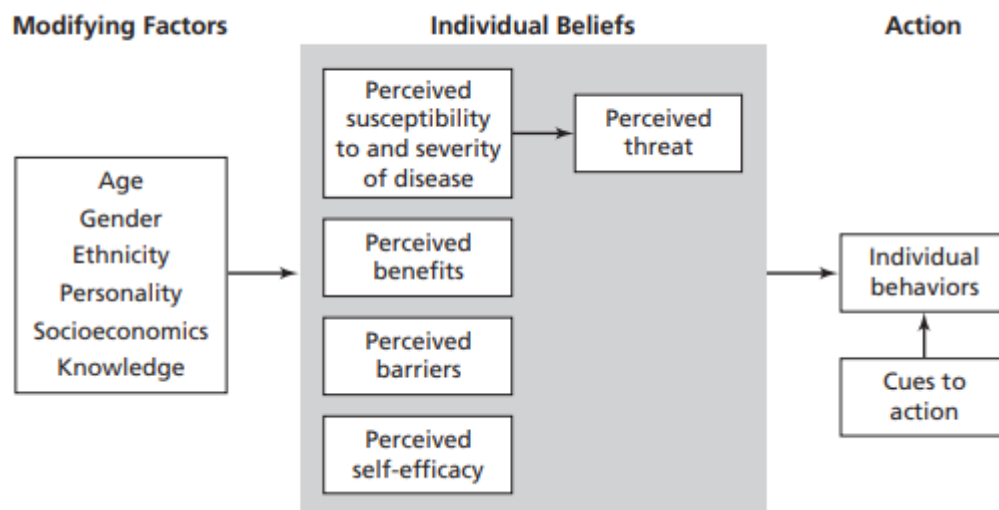


Figure 1.3: Health Belief Model (Champion and Skinner, 2008).

The HBM is a powerful model because its main concept is perceived susceptibility, which is a strong predictor of preventive health behaviour. However, the HBM does not address social and contextual issues. The health educational package developed within this research project is intended to positively influence the community’s perceived susceptibility to TSCT, improve their behaviour and prevent contamination.

1.5 Conceptual Framework

The conceptual framework presented in Fig. 1.4 below is in line with the PRECEDE-PROCEED, IBM, and HBM theories. This framework was used to address the three specific objectives covering the study. It covers all processes from the KAP baseline and socio-demographic factors leading to the development of a community-based health educational package for the control of TSCT. KAP baseline and socio-demographic factors formed the

basis of this thesis, it is where the risk factors assessment was conducted to come up with the key messages that led to the development of the CHEP. This entire process of development of the CHEP relies on community participation.

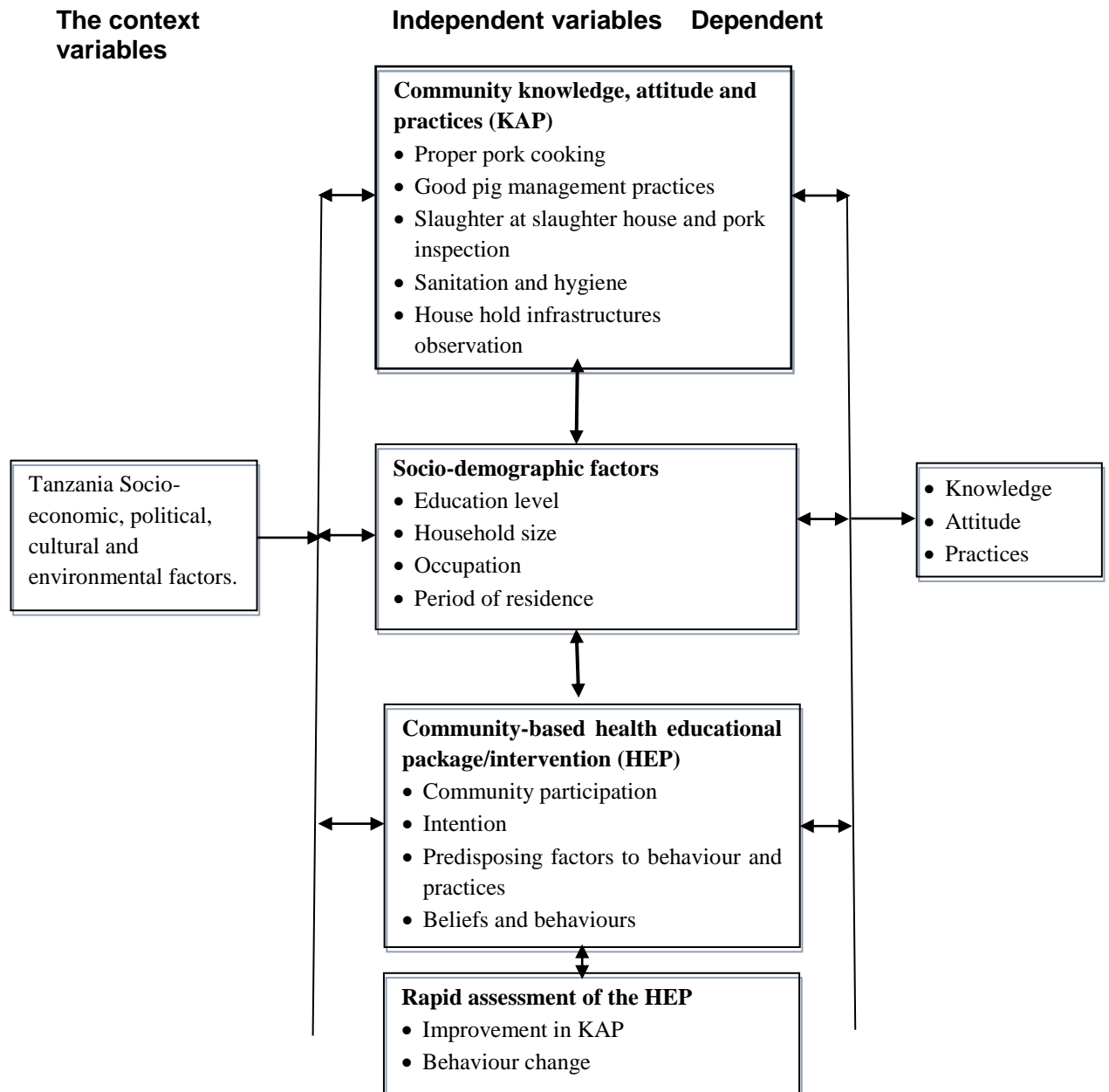






Figure 1.4: Conceptual frameworks for development and assessment of a community-based health education package (HEP) for control of TSCT in Tanzania

Key:  Indicate a one-directional causal relationship, each arrow should start from the independent variable (the cause) and point to the dependent variable (the effect).
 Indicate relationships that are two directional (i.e. A affects B and B also affects A).

1.6 Thesis Outline

To address the study's specific objectives, the study employed a community-based mixed methods approach involving different qualitative and quantitative approaches for triangulation purposes as a means to increase the reliability and validity of findings in this sociological research (Fig. 1.5). The mixed methods involve input from the questionnaire survey and household infrastructure observations of the pig farmers and non-pig farmers. As well as key informants' interviews (KIs) and focus group discussions (FGDs). Risk factors reflecting the natural and human environments such as TSCT transmission, behaviour conducive to TSCT infection as well as the intellectual, emotional, social, and cultural contexts of the selected pig farmers and key stakeholders were assessed using a semi-structured questionnaire, and interview guides from different respondent categories. This proved very useful for the study objectives. Fig. 1.5 shows the overall framework of this study and illustrates the general context of this research, research locations, research activities, data collection tools, analysis tools, and the thesis chapters.

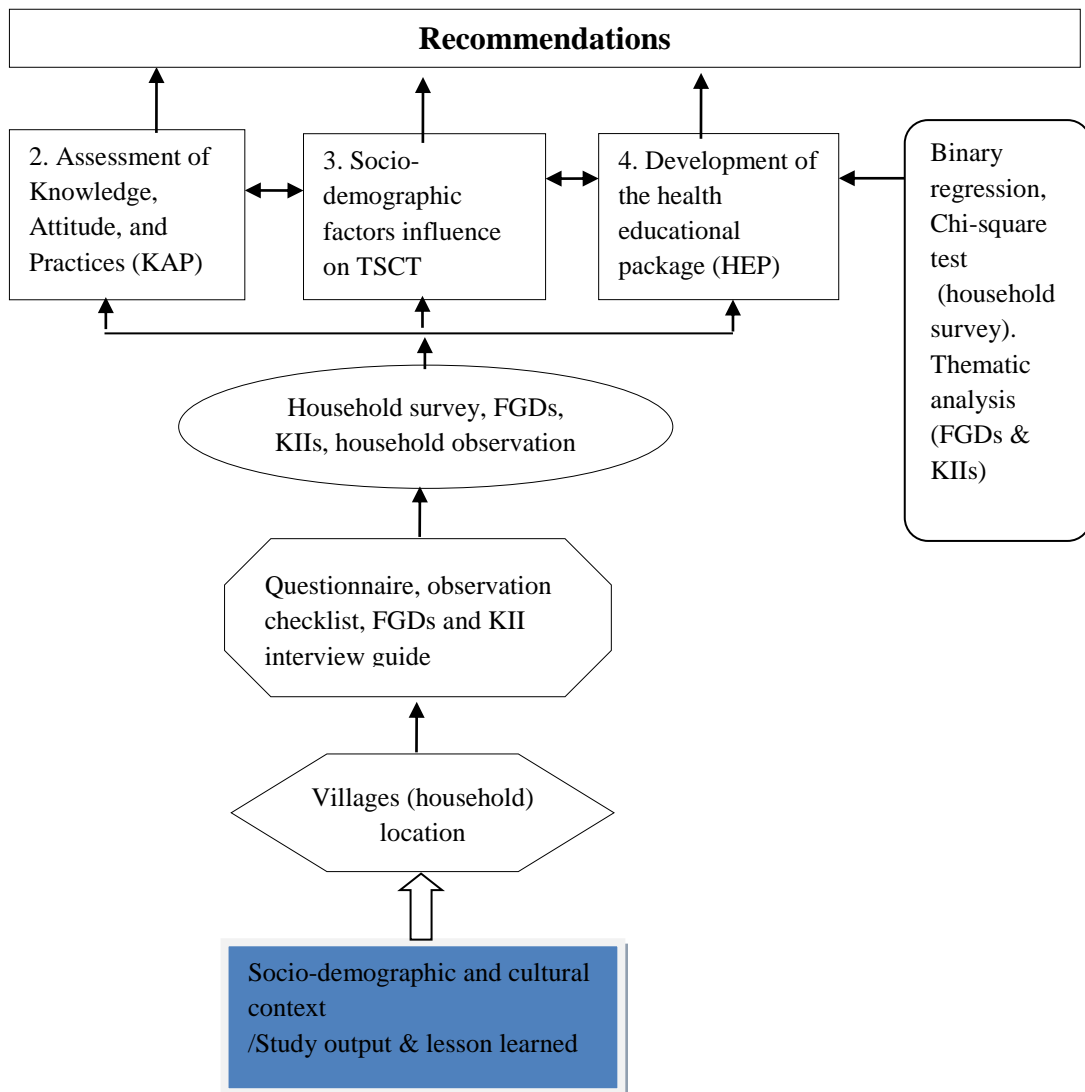


Figure 1.5: General framework of this thesis. The general context (rectangle highlighted blue), research location (hexagon),

data collection tools (octagon), research activities (oval), analytical tools (rounded rectangle), and thesis chapters (numbered square - numbers correspond to the thesis chapters)

This thesis consists of five chapters and two appendices. Chapter one presents background information and a literature review of the current literature. Chapter two is a manuscript on the assessment of knowledge, attitudes, and practices (KAP) about *Taenia solium* cysticercosis and taeniasis in Tanzania. The manuscript presents the data on the KAP level of communities from the study area. Chapter three is a manuscript on the socio-demographic factors influencing knowledge and practice regarding TSCT in Tanzania. The manuscript presents data on the influence of different socio-demographic factors and their importance on various TSCT control programs. Chapter four is a manuscript on the development and rapid assessment of ready-to-use community-based health education package (HEP). The manuscript presents a methodology used for the development of the HEP, the results of the formative research including risk factor assessment, HEP pilot-testing, and the results of rapid assessment. The purpose is to share this methodology and give recommendations for the development of future health educational packages. Finally, Chapter five is a general discussion and conclusion of the key findings of this research.

CHAPTER TWO

2.0 Knowledge, Attitudes, and Practices related to *Taenia solium* Cysticercosis and Taeniasis in Tanzania

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RESEARCH ARTICLE

Open Access

Knowledge, attitudes and practices related to *Taenia solium* cysticercosis and taeniasis in Tanzania



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Abstract

Background: *Taenia solium* cysticercosis/taeniasis (TSCT) is reported to be endemic in pig producing areas around the world, causing significant disease burden and economic losses.

Methods: This cross-sectional study aimed at assessing Knowledge, Attitudes and Practices (KAP) regarding TSCT in four districts, namely Mbulu, Mpwapwa, Mbinga, and Rungwe in Tanzania. Data on KAP were collected through questionnaire-based interviews and household infrastructure observations.

Results: Knowledge about porcine cysticercosis was good, particularly among pig keepers across the districts. Many participants had heard about the pork tapeworm (*T. solium* taeniasis), and the knowledge about signs/symptoms and treatment was fair, but the means of transmission and prevention measures were often unknown. Whilst most participants were familiar with epilepsy, no one knew anything about human cysticercosis and the link between cysticercosis and epileptic seizures. A similar trend is reflected through the attitudes toward the low risk perception of cysticercosis infection. Not surprisingly, the risk perception of the infection with the pork tapeworm was low too. Many participants reported not washing their hands before eating or after using the toilet which highlights potential risks for the development of human cysticercosis. Albeit nearly every participant reported using the toilet always, household observations revealed that toilets were either lacking or had no complete walls. Generally, household observations revealed a discrepancy between questionnaire answers on the one hand and the availability of toilet and handwashing facilities and the confinement of pigs on the other hand.

Conclusion: This study demonstrates knowledge gaps and adverse practices which may hinder and/or slow down the control/elimination of *T. solium* in endemic countries. The study results are also useful for appropriate designing of TSCT health interventions that need to be planned carefully, taking into account the local context and designing TSCT in partnership with the local communities from the beginning to the end applying a One Health approach to allow the possible sustained and best impacts.

Keywords: Knowledge, Attitude, Practices, Smallholder pig farming, *Taenia solium*, Cysticercosis, Taeniasis, Epilepsy, Neurocysticercosis, Cross-sectional study

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Graphical Abstract**Background**

Taenia solium cysticercosis/taeniasis (TSCT) is a parasitic zoonotic disease with severe human/veterinary public health and economic impacts [1]. TSCT is the global number one parasitic foodborne disease as ranked by the World Health Organisation (WHO) [2]. The disease occurs more frequently in countries with poor socio-economic development [3, 4]. Areas with low standards of personal hygiene, poor environmental sanitation, poor pig management, inadequate meat inspection, and limited knowledge of TSCT [5, 6] are the ones severely affected by the disease.

Humans, the final host, harbour the adult tapeworm in their intestines, this condition is referred to as taeniasis; human faeces release infective eggs into the environment [7]. Pigs, the principal intermediate host, get infected through ingestion of eggs from contaminated feed (fruits e.g. pawpaw and mangoes, vegetables, green leaves, leftovers, maize bran, etc.) water, or through direct ingestion of human faeces. The eggs in the intestine release an embryo (an oncosphere), which migrates to the striated muscles and other tissues where it matures into the larval stage (metacestode), commonly known as cysticercus

(singular) or cysticerci (plural) [3]. Humans acquire taeniasis through consuming raw or undercooked infected pork. Cysticerci develop in the small intestine into adult tapeworms leading to taeniasis. After about two months, they mature and start producing eggs, which are passed with faeces isolated as well as inside the gravid proglottids, thus the lifecycle of the parasite between the human and pig hosts is completed [8]. Humans can also act as intermediate hosts and develop cysticercosis after ingestion of eggs from food or water contaminated with human faeces (faecal-oral transmission) or through autoinfection [7]. The development of larvae in the central nervous system tissue, which includes the brain and the spinal cord, leads to neurocysticercosis (NCC). NCC may result in severe or even fatal neurological conditions, which are often manifested through epileptic seizures or epilepsy, severe chronic headaches, and/or focal neurological deficits [1].

Despite the efforts of controlling/eliminate TSCT, the disease is still endemic in many pig-raising regions in Tanzania and around the world, particularly in sub-Saharan Africa, Southeast Asia and Latin America. Several studies using various diagnostic methods in pig keeping

areas of Tanzania reported estimates of the prevalence of porcine cysticercosis (PCC) of between 11.7 and 13% based on lingual examination [9, 10], and 32% based on antigen-based enzyme-linked immunosorbent assay (Ag-ELISA) [9]. The estimates of the prevalence of human cysticercosis (HCC) were between 16.7% using Ag-ELISA and 45.3% using an antibody (Ab)-ELISA [5]. In two neuroimaging studies from rural northern Tanzania, the estimates of the prevalence of NCC among people with epilepsy ranged from 4 to 18% [11, 12], but the overall estimates go even up to 30% prevalence of NCC in people with epilepsy in endemic areas [13, 14]. The societal costs in communities where TSCT is endemic are extremely high. In Tanzania, economic loss was estimated at around 5 million USD per year due to NCC-related epilepsy, and nearly 3 million USD due to PCC for the year 2012 [15]. Poor knowledge regarding risk factors, transmission, signs/symptoms in humans and animals, prevention, and treatment may cause the disease to remain endemic in most regions.

Community knowledge, attitudes, and practices (KAPs) are vital in establishing successful control/elimination strategies for various infections [16]. Adequate knowledge motivates people to adapt control strategies such as the need for treatment of tapeworm infection or improved sanitation, hygiene, and pig-rearing practices, which, in turn, may also help in reducing faecal-oral transmission of various other diseases. KAP survey data can help to recognize gaps in knowledge, cultural beliefs, or behavioural patterns that may facilitate understanding and action, as well as pose problems or create barriers against the disease (TSCT) control/elimination efforts [16]. However, information on KAPs about TSCT in many African countries is limited [6, 17–21]. Accordingly, the current study aimed to evaluate the KAPs of TSCT in endemic districts namely, Mbulu, Mpwapwa, Mbinga, and Rungwe in Tanzania. The results of the current study will also serve as the basis for the development of a contextualised TSCT health education package that will be implemented locally for TSCT control/elimination purposes.

Methodology

Study area

This cross-sectional study was conducted between August 2018 and June 2019 in four selected districts: three districts namely Mbulu (Manyara Region), Mpwapwa (Dodoma Region), and Mbinga (Ruvuma Region) (Fig. 1) were purposely selected for being PCC endemic areas and popular in small-scale pig rearing [6, 18, 20, 22–26]. The fourth district, Rungwe (Mbeya Region) (Fig. 1), was selected for comparison purposes because the endemicity of *T. solium* is unknown.

Nonetheless, the district is popular for small-scale pig rearing and borders neighbouring districts known to be endemic to PCC.

Study design

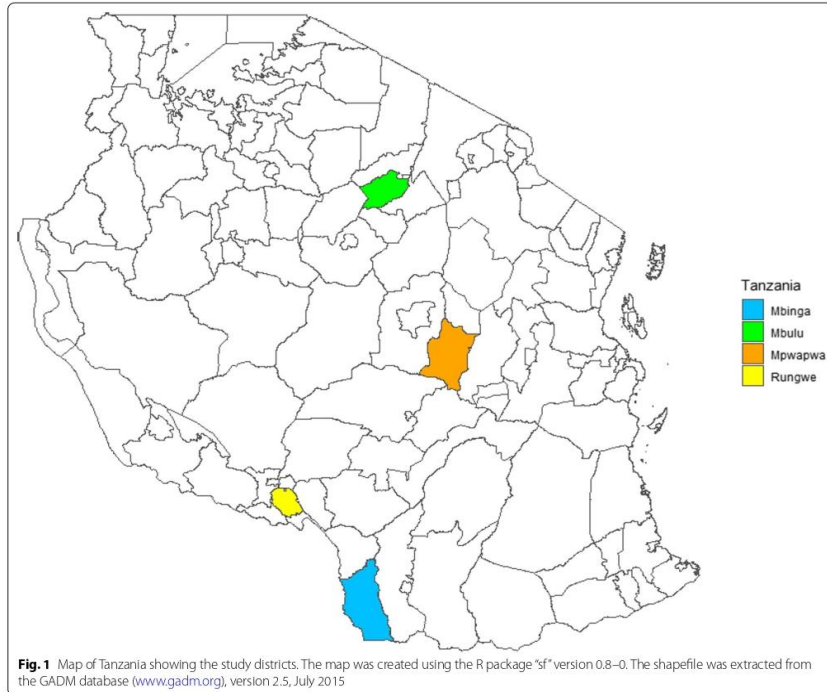
This cross-sectional study consisted of a questionnaire-based survey and direct household infrastructure observation conducted by the main researcher in one village from each of the eight purposely selected wards in the four aforementioned districts (two wards per district). In each village, 60 households were randomly selected, 30 pig keepers and 30 non-pig keepers. A list of all households of pig farmers and non-pig farmers is kept at village level in the office of the village chairperson. The households were stratified according to sub-villages from which they were selected randomly. For pig keepers as they were few, every 2nd name was chosen and for non-pig keepers as they were many every 10th name was chosen. The involvement of pig keepers and non-pig keepers was important for the development of a health education package. In each of the selected households, an interview was conducted with the head of the household. In case the head was absent, another adult household member was interviewed. In addition, a clear colour picture of an adult tapeworm and another of pork infested with cysticerci were shown to the respondents during the interview to ensure that correct information was obtained when referring to a “tapeworm” and “cysticerci” and to reduce the possibility of confusing these with other parasites (Additional file 1). There is a specific name for pork tapeworm (“mnyoo tega wa nguruwe”) in Kiswahili, the local language, which refers to pork tapeworm only, and not to tapeworm overall. This is why when asking “Have you heard about the intestinal tapeworm called *T. solium*?” in Kiswahili and pointing at the picture of the pork tapeworm at the same time, we could be relatively sure that the answers of our participants referred to *T. solium* and not *T. saginata*.

Sample size determination

The sample size was computed using the formula by Fisher [27] assuming a significance level of $\alpha=0.05$ and accounting for four different study areas. Since the level of knowledge, attitude, and practices was not known, the overall frequency of 50% was assumed which yielded the minimum sample size required for this study ($n=384$). We added 25% to account for a non-response and yielded a total number of 480 households.

Questionnaire survey

The questionnaire was designed based on the WHO guide for developing KAP surveys [16]. We also consulted previous studies on KAP in sub-Saharan Africa



[17–21] which inspired us to develop our questions. We phrased our questions according to the local circumstances and piloted the questionnaire as described below.

The questionnaire was administered face-to-face by a team of three investigators (CN, CM, DM; the last two are in the acknowledgement section) and administered separately to each of the selected household members. The questionnaire contained 45 questions altogether. The questionnaire is attached in the supplementary material (Additional file 1: Questionnaire). The general part of the questionnaire contained 7 questions. Knowledge about TSCT was assessed using 22 questions that consisted of 6 questions on the pork tapeworm/taeniasis, 4 questions on HCC, 6 questions on PCC and 6 questions on human epilepsy. Similarly, attitude towards TSCT was

investigated using 4 questions. The practice section contained 12 questions.

All practice-related questions had a value of 1 or 0 (correct response had a value of '1' and a wrong or I don't know response had a value of '0'). A cumulative practice score ranging from zero to 14 points was calculated for every participant and compared by district, demographic and socioeconomic factors using non-parametric tests (Mann–Whitney *U* test and Kruskal–Wallis test).

Before data collection, face validity was assessed in a pilot study on 10 respondents (7 pig- and 3 non-pig farmers) from a village outside the study area, to assess whether the questionnaire was understandable, clear, and easy to follow. The content validity was discussed among three experts (a research supervisor, a co-supervisor, and

a veterinary expert) to decide whether or not the content of the questionnaire met the study objective.

Direct household infrastructure observation

Direct observation and infrastructure assessment to record behaviour/hygiene practices associated with TSCT transmission were conducted using a checklist for each household. Direct observations focused on the presence and quality of toilets and piggens, the presence of handwashing facilities inside or outside the latrines, pig management systems (confinement, tethering, or free-range), and general sanitation of the surroundings.

Data collection

Data were collected using KoboCollect, the application for data collection through KoBoToolBox [28]. All three investigators were trained on the use of the KoboCollect tool before the commencement of the study; the investigators also pre-tested the feasibility and the correctness of the items in the electronic questionnaire. Data were collected by a team of three investigators (CN, CM, DM), the Ward Livestock Field Officer and the District Livestock and Fisheries Development Officer).

Data analysis

Data were exported into a Microsoft Excel spreadsheet for cleaning and storage, and SPSS version 20.0 (Armonk, NY: IBM Corp), for statistical analysis. Descriptive statistics were applied through frequencies and percentages of correct responses. The Chi-square test was used to test for associations between categorical variables. Practice scores were compared by district, demographic and socioeconomic factors using non-parametric tests (Mann–Whitney U test and Kruskal–Wallis test). Data from household observation were also assessed by the Chi-square test. The significance level was $p < 0.05$.

Results

483 participants were included in the study (121 in Mbulu District, 122 in Mpwapwa District, 121 in Mbinga District, and 119 in Rungwe District). 252 participants (52%) were males (Table 1). Most (340, 71%) respondents were older than 35 years. The main source of income for most respondents was livestock keeping (424, 88%); three quarters (367, 76%) of participants were pig keepers. The majority (384, 80%) of the respondents completed primary school education, while 47 (10%) had no formal education. Mbulu District had most of the large size households with above four members per household (57, 47%).

Descriptive statistics for the KAP-related questions are presented in Tables 2 and 3. 233 (48%) respondents had heard about the pork tapeworm (*T. solium* taeniasis) and

many of them (163, 65%) knew the signs/symptoms of an infection, but correct knowledge of transmission was low with only 13 (3%) respondents reporting transmission through poorly cooked pork; many (54, 23%) participants falsely cited contaminated water as the route of pork tapeworm infection. 129 (28%) were aware of the health effects of the pork tapeworm on humans, and 104 (22%) knew about control measures against pork tapeworm infection (Table 2, Additional file 1: Table S1A).

Most (466, 97%) respondents had heard about PCC, every third ($n = 167$) knew the correct transmission of PCC and every other participant (218, 45%) knew control measures against PCC. The last two questions were more commonly known by pig farmers (data not presented). For all these variables, knowledge varied by district ($p < 0.001$ for all three; Table 2, Additional file 1: Table S1B). Most participants had never heard of HCC, hence knowledge about the transmission or HCC preventive measures was poor too. Many people had heard about and knew the signs/symptoms of human epilepsy. About 364 (75%) of the participants knew a person with epilepsy, and 64 (13%) had a family member with epilepsy. However, the link between the pork tapeworm and epileptic seizures was mostly unknown (Table 2, Additional file 1: Table S1d). The source of information for all aspects of TSCT was mainly friends and family members. Health information at school, health centre or through radio and TV were only seldomly mentioned (Additional file 1: Table S1A–D).

Risk perception of infection with the pork tapeworm and the development of cysticercosis was generally very low (20; 4%) and varied between districts ($p < 0.001$ for both questions). In Rungwe, the district with unknown *T. solium* endemicity, the risk perception was particularly low. Overall, 71% of the participants said it was safe and 29% said it was not safe to eat infected pork, but nearly all participants reported taking appropriate measures whenever they saw the infected pork, and these include reporting to the Veterinarian/Livestock Extension Officers and neither selling nor eating the pork (Table 3). Three hundred ninety-two (81%) of the participants ranging from 90% in Mbulu to only 71% in Rungwe ($p < 0.001$) ate pork. As for the practices, 367 (76%) of the respondents were pig keepers and the proportion was evenly distributed across the districts ($p = 0.24$). Most pig keepers, 320 (88%) and 341 (94%) reported confining their pigs during farming season and after harvest respectively, to avoid a penalty/fine or to protect crops and the environment (Table 3). Every fifth pig keeper had slaughtered pigs in their backyard and mostly the pork was inspected after the slaughtering except for Mbulu where only 27% reported meat inspection. Overall, 319, that is, 83% of the participants reported knowing

Table 1 Social demographic characteristics of respondents in four districts

		Mbulu n (%)	Mpwawa n (%)	Rungwe n (%)	Mbinga n (%)	Total n (%)
		121	122	119	121	483
Sex	Male	56 (46)	63 (52)	74 (61)	59 (50)	252 (52)
	Female	65 (54)	59 (48)	47 (39)	60 (50)	231 (48)
Age Groups	18–25	24 (20)	11 (9)	8 (7)	10 (8)	53 (11)
	26–35	17 (14)	36 (30)	17 (14)	20 (17)	90 (19)
	36–50	46 (38)	49 (40)	43 (36)	44 (37)	182 (38)
	> 50	34 (28)	26 (21)	53 (44)	45 (38)	158 (33)
Period of Residence	Below 1	2 (2)	0 (0)	1 (1)	0 (0)	3 (1)
	1–5	12 (10)	5 (4)	5 (4)	13 (11)	35 (7)
	6–10	6 (5)	4 (3)	2 (2)	9 (8)	21 (4)
	Above 10	40 (33)	31 (25)	37 (31)	37 (31)	145 (30)
Respondent Education	All my life	61 (50)	82 (67)	76 (63)	60 (50)	279 (58)
	None	25 (21)	13 (11)	3 (3)	6 (5)	47 (10)
	Primary	86 (71)	101 (83)	102 (84)	95 (80)	384 (80)
	Secondary	6 (5)	7 (6)	14 (12)	14 (12)	41 (9)
Main Occupation	College	4 (3)	1 (1)	2 (2)	4 (3)	11 (2)
	Livestock keeping	117 (97)	100 (82)	108 (89)	99 (83)	424 (88)
	<i>Pig farmers</i>	100/117 (85)	92/100 (92)	75/108 (69)	88/99 (89)	367/424 (87)
	Fishing	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Household Size	Business	4 (3)	24 (20)	9 (7)	19 (16)	56 (12)
	Other	4 (3)	9 (7)	5 (4)	7 (6)	25 (5)
	One	3 (3)	0 (0)	2 (2)	4 (3)	9 (2)
Major Problems in the village	2–3	10 (8)	8 (7)	12 (10)	16 (13)	46 (10)
	4–5	25 (21)	38 (31)	43 (36)	45 (38)	151 (31)
	6–7	26 (22)	46 (38)	38 (31)	41 (35)	151 (31)
	> 7	57 (47)	30 (25)	26 (22)	13 (11)	126 (26)
	Roads	23 (19)	23 (19)	68 (56)	26 (22)	140 (29)
	Water	37 (31)	73 (60)	20 (17)	65 (55)	195 (40)
	Electricity	55 (46)	31 (25)	53 (44)	40 (34)	179 (37)
Household infrastructures observation across the four districts	Dispensaries/Health centres	6 (5)	10 (8)	8 (7)	18 (15)	42 (9)
	Education	1 (1)	3 (3)	0 (0)	1 (1)	5 (1)
	Animal diseases	1 (1)	0 (0)	0 (0)	0 (0)	1 (0)
	Leadership	0 (0)	0 (0)	1 (1)	0 (0)	1 (0)
	No problems	7 (6)	1 (1)	0 (0)	1 (1)	9 (2)

what cysticerci looked like, but this proportion differed by district ($p < 0.001$). Rungwe had the lowest (59, 70%) whereas Mbinga had the highest (98, 91%) proportion. Whilst most participants reported washing their vegetables/fruit before eating, many reported not cooking pork properly. Also, 251 (53%) participants reported washing their hands before eating, and 313 (79%) after using the toilet (Table 3). Overall, the practice score was higher for males than was for females and for pig farmers than was for non-pig farmers; the score increased with education level and differed by district, but was not dependent on age (Additional file 1: Table S2).

Household infrastructures observation across the four districts

Household observations revealed that 362 or 78% of the households had toilets, with four out of five being latrines (274, 80%) and only 20% being flush/pour toilets (69; Table 4). Sanitation in the households was poor with a lack of functional handwashing facilities and poor latrines without cemented floors. Floors in most of the toilets were constructed using sand/clay (219, 64%), and most toilets (272, 78%) had a complete roof. More than half of all toilets had no handwashing facilities. Concerning pig management, 234, that is, 69 percent of the

Table 2 Knowledge of respondents regarding *Taenia solium* taeniasis, porcine cysticercosis, and human cysticercosis

	Mbulu n (%)	Mpwapwa n (%)	Rungwe n (%)	Mbinga n (%)	Total n (%)	p-value
	121	122	119	121	483	
Correct knowledge regarding pork tapeworm (<i>T. solium taeniasis</i>)						
Has heard about the pork tapeworm	54 (45)	57 (47)	63 (53)	59 (59)	233 (48)	0.61
Transmission of the pork tapeworm	4 (3)	2 (2)	2 (2)	5 (4)	13 (3)	0.55
Health effects on humans	18 (15)	26 (21)	40 (34)	45 (37)	129 (28)	<0.001
Pork tapeworm treatment	50 (41)	46 (38)	53 (45)	49 (40)	198 (41)	0.25
Prevention of pork tapeworm infection	22 (18)	21 (17)	33 (28)	28 (23)	104 (22)	0.08
Correct knowledge regarding porcine cysticercosis (PCC)						
Has heard about PCC	119 (98)	119 (98)	107 (90)	121 (100)	466 (97)	<0.001
Transmission of PCC	70 (58)	50 (41)	15 (13)	32 (26)	167 (35)	<0.001
Prevention of PCC	43 (36)	90 (74)	69 (58)	108 (89)	218 (45)	<0.001
Correct knowledge regarding human cysticercosis (HCC) and epilepsy						
Has heard about HCC	5 (4)	7 (6)	3 (3)	14 (12)	29 (6)	0.19
Transmission of HCC	7 (6)	5 (4)	2 (2)	6 (5)	20 (4)	0.42
Prevention of HCC	2 (2)	7 (6)	0 (0)	3 (2)	12 (2)	0.71
Has heard about human epilepsy	105 (87)	118 (97)	116 (97)	120 (99)	459 (95)	<0.001

All p-values are based on a Chi-square analysis of numbers across the four districts

Table 3 Attitude and practices of respondents towards *Taenia solium* cysticercosis/taeniasis

	Mbulu n (%)	Mpwapwa n (%)	Rungwe n (%)	Mbinga n (%)	Total n (%)	p-value
	121	122	119	121	483	
Attitude related questions (risk perceptions and measures against infected pork)						
Do you consider yourself at risk of being infected with tapeworm?—Yes	11/121 (9)	29/122 (24)	13/119 (11)	25/121 (21)	78/483 (16)	<0.001
Are you at risk of being infected with cysticerci?—Yes	6/121 (5)	4/122 (3)	1/119 (1)	9/ (7)	20/483 (4)	<0.001
Is it safe to eat pork infected with cysticerci?—No	44/121 (36)	30/122 (25)	53/119 (45)	14/121 (12)	141/483 (29)	<0.001
Appropriate measures taken for infected pork—Yes	109/121 (90)	112/122 (92)	117/119 (98)	121/121 (100)	459/483 (95)	<0.001
Practices related questions (acceptable preventive practices)						
Eats pork	109/121 (90)	93/122 (76)	84/119 (71)	106/121 (88)	392/483 (81)	<0.001
Pig keeper	100/121 (83)	92/122 (75)	87/119 (73)	88/121 (73)	367/483 (76)	0.24
Pig confinement during farming season	65/100 (65)	92/92 (100)	75/83 (90)	88/88 (100)	320/367 (88)	<0.001
Pig confinement after harvest	82/100 (82)	88/92 (96)	83/83 (100)	88/88 (100)	341/367 (94)	<0.001
Free-range pigs are seen as potential cause of infection	86/121 (71)	90/100 (90)	69/87 (79)	81/88 (92)	326/396 (82)	<0.001
Ever slaughtered a pig in the backyard	26/121 (21)	19/122 (16)	8/119 (7)	41/121 (34)	94/483 (19)	<0.001
If yes, meat was inspected	7/26 (27)	19/19 (100)	6/8 (75)	35/41 (85)	67/94 (71)	<0.001
Participant can identify cysticerci	99/109 (91)	73/93 (79)	59/84 (70)	98/106 (92)	329/392 (84)	<0.001
Always cooks pork properly	72/104 (69)	51/81 (63)	69/81 (85)	81/99 (82)	273/365 (75)	0.002
Always washes vegetables and fruits before eating raw	112/121 (93)	119/122 (98)	114/119 (96)	120/121 (99)	465/483 (96)	0.04
Always washes hands with soap before eating	68/120 (57)	87/120 (72)	47/116 (40)	49/121 (40)	251/477 (53)	<0.001
Always treats drinking water	37/121 (31)	44/122 (36)	57/119 (48)	56/121 (46)	194/483 (40)	0.02
Always uses toilet/latrine	117/121 (97)	122/122 (100)	118/119 (99)	121/121 (100)	478/483 (99)	0.03
Always washes hands with soap after toilet use	74/94 (79)	92/103 (89)	73/101 (72)	74/99 (75)	313/397 (79)	0.02

All p-values are based on a Chi-square analysis of numbers across the four districts

Table 4 Household infrastructures observation

	Mbulu n (%)	Mpwapwa n (%)	Rungwe n (%)	Mbinga n (%)	Total n (%)	p-value
	121	122	119	121	483	
Households with toilet	90/120 (67)	100/110 (91)	101/117 (86)	71/115 (62)	362/462 (78)	< 0.001
Complete toilet wall	75/90 (83)	98/100 (98)	100/101 (99)	68/71 (96)	341/362 (94)	< 0.001
Complete toilet roof	65/86 (76)	75/94 (80)	76/95 (80)	56/69 (81)	272/344 (79)	0.850
Toilet floor material						< 0.001
Clay/sand	70/86 (81)	67/94 (71)	52/95 (55)	30/69 (43)	219/344 (64)	
Cement	15/86 (17)	27/94 (29)	35/95 (37)	34/69 (49)	111/344 (32)	
Wood/tiles	1/86 (1)	0/94 (0)	8/95 (8)	5/69 (7)	14/344 (4)	
Type of toilet						< 0.001
Flushing/pour toilet	3/84 (4)	10/97 (10)	31/95 (33)	25/68 (37)	69/343 (20)	
Pit latrine	81/84 (96)	87/97 (90)	64/95 (67)	43/68 (63)	274/343 (80)	
Faeces seen on toilet floor	1/86 (1)	1/94 (1)	1/95 (1)	0/69 (0)	3/344 (1)	0.577
Hand washing facilities in toilet						< 0.001
Yes, ≤ 5 m	19/86 (22)	20/94 (21)	44/95 (46)	33/69 (48)	116/344 (34)	
Yes, > 5 m	2/86 (2)	2/94 (2)	0/95 (0)	0/69 (0)	4/344 (1)	
No hand washing facilities	65/86 (76)	60/94 (64)	52/95 (55)	36/69 (52)	213/344 (62)	
Hand washing soap in toilet	11/86 (13)	14/94 (15)	11/95 (12)	1/69 (1)	37/344 (11)	< 0.001
Presence of pigpen in the household	65/120 (54)	83/110 (75)	77/117 (66)	68/115 (59)	234/462 (51)	0.012
Pigpen floor materials						< 0.001
Sand/clay	56/65 (86)	73/87 (88)	59/77 (77)	9/68 (13)	197/234 (67)	
Cement	2/65 (3)	6/83 (7)	2/77 (3)	33/68 (49)	43/234 (15)	
Wood	4/65 (6)	4/83 (5)	13/77 (17)	26/68 (38)	47/234 (16)	
Other materials	3/65 (4)	0/83 (0)	3/77 (3)	0/68 (0)	6/234 (2)	

All p-values are based on a Chi-square analysis of numbers across the four districts

households had a pigpen which most commonly had a sand/clay floor except for Mbinda District where most of the pigpens had cement floor (Table 4, Fig. 2).

Discussion

In this study, we evaluated knowledge, attitudes and practices towards TSCT in rural Tanzania, by a combined assessment through a questionnaire survey and households inspection. Interestingly, almost all the participants had heard about PCC, half of the participants knew about the pork tapeworm (*T. solium* taeniasis), but almost nobody had heard anything about HCC. The questionnaire also revealed that knowledge of the means of transmission and the various aspects of pork tapeworm and HCC prevention was particularly poor, although the latter is not surprising as no one had ever heard anything about HCC. The knowledge on the transmission and prevention of PCC was fair in the aforementioned areas. The effects of *T. solium* on human health (taeniasis and NCC) were not well known, although knowledge of signs/symptoms of taeniasis was fair, compared to knowledge of the effects on pig health which were mainly known among pig keepers. The general good knowledge about PCC may be attributable to epidemiological studies on PCC conducted previously in the districts (25,26) and information obtained through village meetings/gatherings, household visits by Extension Officers or leaflets.

Not only was the knowledge on the impact of *T. solium* on human health and HCC in general limited, but also many participants did not consider themselves at risk of *T. solium* infection, despite living in areas with high *T. solium* endemicity and having heard about the parasite before, at least in the context of *T. solium* taeniasis. This was surprising because several studies on *T. solium*, with different research questions, had previously been conducted in some of the study districts [6, 18, 20, 22–24, 29, 30]; among these studies were also studies that assessed appropriate *T. solium* health education packages which proved successful. This means that health education packages may not have had sustained effects on knowledge and practices regarding TSCT and that new health education packages not only need to deliver information on *T. solium* but also need to include the risk perception of participants. Health education packages, therefore, have to be perceived as an iterative process including not only the researchers and the local authorities but also and foremost the local communities from the beginning and throughout the entire process in a co-creative design.

To the best of our knowledge, to date, no studies regarding TSCT have been conducted in the Rungwe district. Nonetheless, participants from Rungwe showed similar results to those shown by participants in other districts in all KAP domains. This may be a result of good extension services and other interventions on sanitation



Fig. 2 Pigpen construction with clay floor and wood fence

and hygiene in this district. This could also be attributable to knowledge spill over from the adjacent districts that are known to be PCC endemic thus representing a desirable effect. In addition, the district is popular for intensive dairy cattle management which may further explain their pig management system and pig feeding practices. Thus, knowledge transfer from one knowledge domain to another should not be underestimated, instead, it should be explored in health education programmes.

On average, pig keepers knew that free-roaming of pigs and exposure to human faeces and contaminated feeds were central to the transmission of *T. solium* infection. This finding is comparable to the findings from several other studies conducted in Tanzania [8, 9, 24, 25]. On the contrary, most respondents had never heard of HCC, possibly due to a lack of knowledge among medical staff and/or lack of appropriate diagnostic tools. It seems that people are hardly ever diagnosed with HCC (especially NCC) outside research projects in sub-Saharan Africa as access to neuroimaging facilities is mandatory for the correct diagnosis of NCC but very costly. However, our findings are not unusual. Also, other studies conducted in areas highly endemic to *T. solium* showed low awareness of HCC/NCC [18, 31, 32]. Interestingly, knowledge

about epilepsy was high, but not many people knew that *T. solium* cysticercosis is one of the causes of epilepsy.

In general, the level of knowledge on PCC was good. This may be because almost three-quarters of the respondents were pig farmers who might have acquired their knowledge from Livestock Field Officers (LFO) and other extension agents allocated to their respective villages. In the present study, most participants, especially pig farmers were aware of the predilection sites of *T. solium* cysticerci in the infected pig; under the tongue being the most commonly mentioned site. This may be because when selling pigs to traders, they usually check for the presence of cysticerci under the tongue. Regarding the aetiology of PCC, some interesting misconceptions persist. Pawpaw seeds and jiggers (sand fleas) were reported by a few farmers as causes of PCC, all of the farmers were from Rungwe District where feeding fruits to pigs is a very common practice (results not presented). This is probably because of the similarity in the morphology of *T. solium* cysticerci to pawpaw seeds and jiggers (sand fleas). This confusion implies that although general knowledge of PCC was good, there is still a need for health education to consolidate knowledge even among pig farmers.

In our study, most of the pig farmers visited had access to veterinary services and were frequently visited by LFO. This is likely the reason, why pig farmers had often higher knowledge about *T. solium* related health questions. This may indicate access to some education interventions that had already been conducted before. Information for farmers is mostly provided by LFO through village meetings, and sometimes through household visits during the treatment of pigs, usually focusing on PCC and other animal-related diseases. LFOs usually encourage farmers to confine their pigs without including proper information on feeding and/or TSCT control/elimination, in general. Likewise, it is customary for medical practitioners in health facilities to provide education on environmental sanitation, personal hygiene, and human health-related matters. In most cases, only patients and expectant mothers visiting health facilities for other medical services benefit from such education, while the rest of the community members remain uninformed. This rather siloed approach calls for a One Health perspective, that is, the close collaboration of medical doctors and nurses, veterinarians, and LFO together with environmental and sanitation officers in addressing the matter. There is a need for joint training and information campaigns in the communities to provide cross-sectoral information on TSCT. Ultimately, the One Health collaboration should not only concern communities at the grassroots level but also relevant policymakers at the district, regional and national levels.

Practices reported by the respondents during our questionnaire survey often differed from those observed during direct household observations. While the majority of the respondents reported always using the toilet, household observations found many households without toilets. One of the striking observations was that in some of the visited households, children's faeces was disposed of directly into pigpens, which enhances the completion of the *T. solium* life cycle. Three-quarters of the respondents reported washing their hands with water and soap after using the toilet, but household observations found that less than half of all toilets had installed handwashing facilities, commonly known as tippy taps; but most of them were without water or soap on grounds that the tippy taps were emptied to safeguard the health of children who used to play with them and drink the water from the handwashing facilities. Furthermore, while the majority of the respondents reported confining their pigs, nearly half of the households had either no pigpens or pigpens with spaces for pigs, especially piglets, to escape and roam freely. The discrepancy between questionnaire responses and household observations shows the importance of direct observation in assessing KAP as many questions may be given socially desired responses.

Our findings are not only relevant for local stakeholders but also for the overall target of control/elimination of TSCT as outlined in the WHO roadmap for neglected tropical diseases 2021–2030 [33]. The roadmap also mentions four cross-cutting targets for 2030 which include (1) integrated approaches, (2) multisectoral coordination, (3) universal health coverage and (4) country ownership. Other important points made include the involvement of local communities by social mobilisation at the very basis of every health intervention, knowledge sharing, and prevention strategies targeted at local situations. The current project is following those principles, and in a second step, a contextualised and co-created health education intervention will be developed. The WHO roadmap for neglected tropical diseases also emphasizes the integrated approaches and multisectoral coordination which calls for a One Health approach to the plan. Our study demonstrated that knowledge was rather different between PCC and HCC/NCC which shows clear potential for the engagement of the humans, animals and environmental sectors beyond their boundaries, that is, medical officers informing about the relevant animal diseases and LFO informing about human diseases. In addition, environmental services need to be promoted and brought into the big picture as most transmission happens because of a lack of hygiene and within various environmental compartments. However, this also requires adopting a “whole of the system” approach, where the human, animal and environmental sectors need to be strengthened in an equitable manner, which, in turn, requires good One Health governance at different levels. The objectives and results of our study contribute to the educational One Health approach of TSCT in the control/elimination and prevention. Although community-based TSCT health education has shown to have an impact on HCC and PCC [34, 35], the integration of different TSCT One Health approaches, including treatment of PCC and taeniasis, the prevention of PCC by vaccination and health education, seem to be able to fully eliminate active PCC [35].

Strengths and limitations

The strength of this study is its large sample size of almost 500 households, that comprehensive knowledge about TSCT was evaluated and that the answers were checked by household infrastructure observation. In surveys, the respondents tend to respond to questions in a socially desirable way. Conducting household infrastructure observations, we were able to confirm or discard some of the responses to the questionnaire. This was not only important for the quality of the results of the current paper but also for the health education package which was developed based on the results of this study.

Our study also had limitations. One limitation was that although a pilot study was conducted only 10 households were included due to logistic reasons and time constraints. Another limitation was that our questionnaire used pre-specified answers which allowed the guessing of correct answers. However, we controlled this by using enumerators during the household survey. The enumerators asked questions without first revealing the possible answers. Another limitation was that the questionnaire was administered by three different people, but as answers were prespecified, this may not have had a large effect. Also, only one person per household was interviewed which may have pre-selected people who are more knowledgeable about TSCT. The degree of this bias, however, could not be verified. In addition, we were able to identify gaps in knowledge about the link between TSCT and human disease, but we neither assessed the prevalence of PCC nor HCC in the study districts. For PCC, three of the four districts were known to be highly endemic for *T. solium*, but not necessarily the villages we studied. PCC and HCC were likely prevalent in the study villages, but as we did not investigate this we were not able to establish the relationship between low or incorrect KAP and high prevalence of PCC and/or HCC. However, the evaluation of the impact of KAP and an especially designed community-based health education package (for explanation see above) on the presence or absence of PCC/HCC within the large health consortium of CYSTINET-Africa is currently underway and the results will most likely be presented towards the end of the year.

Conclusions and recommendation

This study has revealed poor knowledge of TSCT with generally better knowledge about aspects related to pig health compared to the aspects related to human health. There was fair knowledge of epilepsy but the connection between NCC and epilepsy was not made. The limited general knowledge and negative practices (although the overall practice score was acceptable) may represent an important barrier to the control and elimination efforts of TSCT. It is, therefore, necessary to scale up the efforts in knowledge sharing with the public on transmission, TSCT signs/symptoms, control, treatment and prevention in Tanzania, preferably in a One Health approach, for the control and eradication of TSCT. The results from our study influence the design of context-specific health education packages that may help reach some of the goals specified in the WHO roadmap for neglected tropical diseases 2021–2030.

Abbreviations

TSCT: *Taenia solium* cysticercosis/taeniasis; KAP: Knowledge, attitude and practices; LFO: Livestock field officers; Ag-ELISA: Antigen-based enzyme-linked immunosorbent assay; HCC: Human cysticercosis; NCC: Neurocysticercosis; PCC: Porcine cysticercosis; WHO: World Health Organization.

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12879-022-07408-0>.

Additional file 1: Table S1A. Knowledge about pork tapeworm (*T. solium* taeniasis). **Table S1B.** Knowledge about porcine cysticercosis. **Table S1C.** Knowledge about human cysticercosis. **Table S1D.** Knowledge about epilepsy. **Table S2.** Practice score of *Taenia solium* taeniasis/cysticercosis (TSCT) by specific variables. Questionnaire

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Authors' contribution

CN, HAN, EMM, VS, ASW, and CM designed the study. CN, EMM, and CM performed the survey. CN and DS analysed the data. CN, AJC, HAN, EMM, ASW, CM, DS, and VS collaborated to write the manuscript. All authors read and approved the final manuscript.

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Availability of data and materials

The data used and/or analysed during the current study as well as any extra materials are not publicly available due to being part of an ongoing study but are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate

The study was approved by the National Institute for Medical Research (NIMR) with approval number NIMR/HQ/R.8a/Vol. IX/2802. The study also received approval from the ethics committee of the Klinikum rechts der Isar, Technical University of Munich, Germany, under the number 537/18 S-KK. Each participant was informed about the study and oral consent for the questionnaire and household infrastructure observation was obtained from each participant before the commencement of the study.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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CHAPTER THREE

3.0 Socio-demographic factors influencing knowledge, attitude and reported practices regarding *Taenia solium* cysticercosis taeniasis in Tanzania

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Socio-Demographic Factors Influencing Knowledge, Attitude, and Reported Practices Regarding *Taenia Solium* Cysticercosis Taeniasis in Tanzania

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Keywords:

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Taenia solium Cysticercosis/Taeniasis (TSCT) is a neglected zoonotic disease with significant public health and socio-economic impacts. TSCT is endemic in areas with low socio-economic development. This study examined the influence of socio-demographic factors on community knowledge, attitude, and practices regarding TSCT control in Mbulu, Mpwapwa, Mbinga, and Rungwe districts of Tanzania. The study employed a cross-sectional design, and data were collected using a questionnaire, which was administered to 483 randomly selected households in the study districts. In addition, qualitative data were collected using key informant interviews (KIIs) from 38 purposively selected respondents and 12 focus group discussions (FGDs). Quantitative data were analysed in SAS 9.4 using binary logistic regression with education, location, gender, age, occupation, source of income, the duration of residence (years), savings and credits cooperative society (SACCOS) membership, and household size included in the model as predictors of knowledge, attitude, and/or practices related to TSCT control. The qualitative data were analysed in ATLAS.ti 8. Findings show that respondents with post-primary education were more likely to have heard of tapeworm (P = 0.0071), be aware of *T. solium* transmission (P = 0.0396), aware of *T. solium* health effects (P = 0.0212), and be knowledgeable on human cysticercosis (HCC) health effect (P = 0.003) compared to respondents with no formal education. With regard to practices, respondents from Mpwapwa district were more likely to report washing their hands with soap before eating (P = <0.0001). It is, therefore, recommended that strategies involving health education intervention should consider the inclusion of socio-demographic, cultural, economic, and location factors for effective and sustainable control of the parasite.

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INTRODUCTION

Taenia solium Cysticercosis/Taeniasis (TSCT) is a neglected zoonotic disease with significant public health and socio-economic impact worldwide (WHO, 2015a). TSCT was ranked first on the global scale of food-borne parasites (FAO and WHO, 2014). *Taenia solium* is endemic in many countries with poor socioeconomic status, especially in Africa, Asia, and Latin America (Coral-Almeida et al., 2014; Okello and Thomas, 2017). TSCT is a preventable disease that can be eradicated and which affects more than 50 million people around the world (Eddi et al., 2003; WHO, 2013). About 50 thousand people die every year as a consequence of neurocysticercosis (NCC) (Román et al., 2000; WHO, 2015a). A study conducted in Tanzania in 2012 reported an economic loss of 5 million USD annually due to NCC-related epilepsy and nearly 3 million USD due to PC for the year 2012 (Trevisan et al., 2017).

The life cycle of *T. solium* involves pigs, which are the principal intermediate hosts of the parasite, though humans may also act as accidental intermediate hosts being infected with the larval stage of *T. solium* through ingesting infective eggs (Kraft, 2007; Gabriël et al., 2017). In the intestine, the *T. solium* egg releases an embryo, which

migrates primarily to the muscles and other tissues, where it matures into a larval stage commonly known as cysticerci (Murrell, 2005). The development of larvae in the central nervous tissues leads to neurocysticercosis (NCC) resulting in epileptic seizures, severe chronic headaches, focal deficits, or death of infected individuals (WHO, 2015b). Humans (definitive host) acquire tapeworm in the small intestine, leading to taeniasis following ingestion of raw or undercooked infected pork (Gabriël, et al., 2017). After about two months, the tapeworm matures and starts producing eggs, thus completing the life cycle (Gabriël et al., 2017). Eggs of *T. solium* may be passed with human faeces and become a source of infection to pigs and humans if the faeces are not properly disposed of. There is limited information on the influence of socio-demographic factors on knowledge, attitude, and practices regarding TSCT in Tanzania.

Knowledge may encourage people to become accustomed to TSCT control strategies, like the necessity for treatment of taeniasis or improved sanitation, hygiene, and good pig-management practices towards control of faecal-oral transmission of several other diseases (Sarti et al., 1997; Ngowi et al., 2008, 2011; Wohlgenut et al., 2010; Alexander et al., 2012; Mwidunda et al., 2015; Carabin et al., 2018; Vaernewyck et al.,

2020). The population knowledge, attitude, and practices (KAP) are vital in instituting effective control strategies for various infections (WHO, 2008). However, there is still limited data on the influence of socio-demographic factors on the KAP of populations on TSCT in endemic areas (Ngowi et al., 2011; Chacha et al., 2014; Mwidunda et al., 2015).

Although interventions to control *Taenia solium* cysticercosis taeniasis have been implemented in Tanzania, the disease remains prevalent, and knowledge about the disease and its control practices in communities is inadequate. Therefore, this research aimed to investigate the influence of socio-demographic factors on community knowledge and practices regarding TSCT control in Tanzania. This study assessed the influence of different socio-demographic factors on KAP to prevent or control TSCT in Tanzania.

THEORETICAL FRAMEWORK

The study was guided by the Health Belief Model (HBM) (Champion and Skinner, 2008) and the Socio-Ecological Model (SEM) (Kilanowski, 2017; Nji et al., 2021). The HBM suggests that people's health-related behaviours are influenced by their beliefs about the severity of the disease, their susceptibility to the disease, the perceived benefits of taking preventive measures, and the barriers to taking preventive measures (Townsend and Foster, 2011). The SEM, on the other hand, emphasises the influence of social and environmental factors on health behaviours. The SEM suggests that health behaviours are shaped by the interaction between the individual, the social environment, and the physical environment.

The HBM was used to explore the factors that influence community knowledge and practices regarding TSCT control (Champion and Skinner, 2008). The model suggests that community members' perceptions of the severity of the disease, their susceptibility to the disease, the perceived benefits of taking preventive measures, and the barriers to taking preventive measures influenced their knowledge and practices regarding TSCT control (Champion and Skinner,

2008). For example, community members perceive TSCT as a severe and life-threatening disease, so they are more motivated to take preventive measures such as proper sanitation and hygiene practices to prevent infection.

The SEM was used to explore the social and environmental factors that influence community knowledge and practices regarding TSCT control (Nji et al., 2021). The model suggests that the community's social norms, values, and beliefs, as well as the physical environment, influence their knowledge and practices regarding TSCT control (Townsend and Foster, 2011; Nji et al., 2021). For example, some communities value cleanliness and hygiene; as such, they are more likely to engage in practices such as proper disposal of human waste, which can prevent the spread of TSCT (Kilanowski, 2017; Nji et al., 2021).

Therefore, the Health Belief Model and the Socio-Ecological Model were used to explore the influence of socio-demographic factors on community knowledge and practices regarding TSCT control in Tanzania. The models provide a theoretical framework for understanding the factors that influence community knowledge and practices regarding TSCT control and guide the development of interventions to improve community awareness and prevent the spread of the disease.

MATERIALS AND METHODS

Description of the Study Area

The study was conducted in four districts, namely Mbulu (Manyara region), Mpwapa (Dodoma region), Mbinga (Ruvuma region), and Rungwe (Mbeya region), between August 2018 and October 2021. The districts were purposely selected due to their popularity in small-scale pig rearing and reported disease endemicity (Ngowi et al., 2004, 2008, 2009; Boa et al., 2006; Mwidunda et al., 2015; Shonyela et al., 2017; Mwang'onde et al., 2018).

Sample Size Estimation

For the quantitative study, the sample size was estimated using the formula by Fisher et al.

(1991). The assumed prevalence of 50% of TSCT was used in the computation of the minimum sample size required for this study.

$$n = \frac{z^2 pq}{d^2}$$

Where: $Z\alpha$ = standard normal deviation = 1.96; p = estimated prevalence. = 0.5 (50 %); q = (1 - p) = 0.5; d = (Precision) = 0.05

$$n = \frac{1.96^2 * 0.5 * 0.5}{0.05^2} = 385 \text{ respondents}$$

We added 25 per cent to account for a design effect and yielded a total number of 480 households.

Selection of Study Villages and Households

Eight villages were purposively selected from four wards in the four districts based on the numbers of small pig-keeping households. In the quantitative component, a simple random sampling technique was applied to select the households from each village. Equal numbers of households were selected from each hamlet. The household heads were interviewed in each household; in the absence of the household head, an adult household member was interviewed using a structured questionnaire. The participants for the qualitative part were purposively selected.

Data Collection

The study adopted the mixed methods approach whereby both qualitative and quantitative data were collected for triangulation purposes to increase the reliability and validity of findings (CDC, 2013).

Household Survey

A questionnaire that included knowledge attitudes and practices (KAP) of pig and non-pig farmers was administered to the participants from each of the selected households. The questionnaire comprised both closed- and open-ended questions relating to socio-demographic factors and knowledge of *T. solium* taeniasis/cysticercosis (TSCT), its transmission, symptoms, prevention,

treatment, attitude, and practices towards TSCT (Supporting file 1).

Focus Group Discussions (FGDs)

A purposive sampling technique was used to select participants for FGDs, i.e. village health committee (VHC) and science subject teachers from primary and secondary schools. The FGDs were led by a trained moderator who was fluent in Kiswahili, the national language, using the FGD guide (supporting file 2). In addition to audio recording, the discussions were also recorded in a notebook. This provided an opportunity for the note-takers to also record non-verbal responses, including gestures and other non-verbal information. Two FGDs were conducted in each village; the plan was to conduct 16 FGDs (2 FGDs in each village). We ended up with 14 FGD as two villages had no active VHC; of the 14 FGDs conducted, we ended up with 12 FGD as two were of poor audio quality and had to be rejected during transcription. Participants were asked to attend a specially arranged session of one to two hours for FGDs. Each FGD contained a minimum of 6 and a maximum of 12 participants.

Key-Informant's Interviews (KIIs)

A purposive sampling technique was used to select key informants, i.e. livestock/veterinary officers, health officers/practitioners, community development officers, environmental and sanitation officers, ward education officers, district education officers (primary and secondary school), heads of primary and secondary schools, and local government leaders including village leaders. A total of 38 KIIs were conducted in eight villages from the four districts using a KIIs guide (supporting file 3). The guide was used to explore insights into the real issues regarding factors influencing the transmission, signs/symptoms, control, and treatment of TSCT infection from the key informants. Discussions were recorded in a digital voice recorder upon their consent.

Quality Assurance

Questionnaire enumerators were trained on the use of the data collection tools the KoboCollect

(Humanitarian Response, 2015). This application was installed on tablets and was pre-tested in a village far from the study villages before the commencement of the study. Field team leaders and enumerators were also engaged in reviewing the data collection tools to correct any inconsistencies that could arise.

Data Analysis

Quantitative Data Analysis

From the KoboCollect data collection app, the data were exported to MS Excel and analysed in Statistical Analysis System (SAS®) version 9.4 (SAS Institute Incorporation, USA). Binary logistic regression was used to assess the influence of socio-demographic factors on KAP regarding TSCT. A *P* value of <0.05 was considered to be statistically significant.

Qualitative Data Analysis

The audio-recorded KIIs and FGDs were transcribed verbatim into MS Word documents. They were then translated into English by two independent researchers and compared for consistency. To improve interpretation reliability, the written transcripts were reviewed independently by the same two researchers to ensure the consistency of the transcripts against the audio files and to ensure the accuracy of the transcribed files before their analysis. The analysis of the KIIs and FGDs transcripts was carried out in ATLAS.ti 8 for Windows (Scientific Software Development GmbH, Berlin, 2019). The content and thematic analyses were conducted to identify emerging themes. The process of analysis involved familiarisation with the data, development of initial codes based on the research questions and issues emerging from data, refinement of codes, and their allocation to broad themes.

Variables Analysed

During statistical analysis (binary logistic regression), both independent and dependent variables were used.

The dependent variables were;

Knowledge

Attitude,

Practices.

The Independent variables were sex (male and female); district/location (Mbulu, Mpwapwa, Rungwe, and Mbinga); educational level (no formal education, primary education, and post-primary education); age in years (16-35, 36-55 and more than 55); occupation (livestock keeping, livestock keeping and business, farming and livestock keeping); The main source of income categorised as (farming, farming and livestock keeping, farming and business); Average household size was (1-2, 3-4, and above 4 members); period of residence in years was (1-5, 6-10, and > 10 years); Savings and Credit Cooperative Society (SACCOS) membership categorised as (yes and no).

Whereby the reference categories were set as follows; *Education level*, the reference category was no formal education; *Household size*, the reference category was 1-2 household members; *Age group*, the reference category was above 55 years; *Gender*, the reference category was female; *Occupation*, the reference category was livestock keeping and business; *The main source of income*, the reference category was farming and business; *Period of residence* in a village, the reference category was period of 1-5 years; *SACCOS membership*, the reference category was no; *District/location*, the reference category was Rungwe district.

RESULTS

Social Demographic Characteristics of Respondents

A total of 483 respondents were interviewed, out of whom 52% were male. Of these, approximately 88% reported having lived in their village for more than 10 years, most of whom had been born and raised in the same village. Almost half (47%) were in the age of 36-55 years, followed by 30% who were 16-35 years, while about 23% were above 55 years. The majority (80%) of the respondents had completed primary school

education. The main occupations of 79% of the respondents were farming and business. The main source of income for about 87% of the respondents was farming, with about 76% keeping pigs.

Socio-Demographic Factors Associated with Respondent's Knowledge of Tapeworm

Respondents with post-primary education, OR 12.326 (95% CI: 1.456-104.332, $P = 0.0212$) were 12.326 times more likely to be aware of the health effect of tapeworm infection compared to

those with no formal education). Respondents from Mpwapwa district, OR 18.766 (95% CI: 2.189-160.890, $P = 0.0075$) were 18.766 times more likely to be aware of the health effect of tapeworm infection compared to those from Rungwe district (Table 1). This study revealed that educational level, district of residence, age, period of residence, household size, savings and credits cooperative society (SACCOS) membership, sex, the main source of income, and occupation were important determinants of KAP regarding TSCT.

Table 1: Socio-demographic factors associated with respondent's knowledge of tapeworm

Independent variables	B	SE.	Wald χ^2	p-value	ORs
Knowledge of tapeworm (<i>T. solium</i>)/taeniasis					
Intercept	-0.6670	1.2007	0.3086	0.5785	-
Primary school education	1.8796	1.0161	3.4221	0.0643	6.551
Post-primary school education	2.5117	1.0897	5.3124	0.0212*	12.326
SACCOS membership	-1.5364	0.3447	19.8735	<.0001*	0.215
Mbulu district	1.3742	0.8408	2.6712	0.1022	3.952
Mpwapwa district	2.9320	1.0963	7.1529	0.0075*	18.766
Mbinga district	-0.3903	0.3432	1.2934	0.2554	0.677
Period of residence (6-10 years)	2.3456	1.2332	3.6178	0.0572	10.439
Period of residence (>10 years)	-0.4727	0.6011	0.6184	0.4316	0.623
<i>Note: Wald χ^2 (8) = 43.5829, Prob < 0.0001, significant at $P < 0.05$, c-statistic=82%, H-L (p = 0.8975). The dependent variable in this analysis is the health effect of tapeworm coded so that 0 = No and 1 = Yes.</i>					
ORs knowledge of the risk of tapeworm infection					
Intercept	-2.0985	0.2939	50.9936	<.0001	-
Mbulu district	-0.2041	0.4431	0.2121	0.6451	0.815
Mpwapwa district	0.9089	0.3646	6.2141	0.0127*	2.482
Mbinga district	0.8176	0.3708	4.8622	0.0275*	2.265
<i>Note: Wald χ^2 (3) = 12.8368, Prob = 0.0050, significant at $P < 0.05$, c-statistic=62%, H-L (p = 1.0000). The dependent variable in this analysis is the knowledge of the risk of tapeworm infection and, coded so that 0 = no and 1 = yes.</i>					
<i>Odds ratios (ORs) were estimated using the maximum likelihood method.</i>					
<i>*Statistically significant at $P < 0.05$, H-L = Hosmer and Lemeshow Test.</i>					

Qualitative data supported these findings in terms of the level of education. There was mixed information among the participants regarding *T. solium* transmission as well as awareness of the health effects as echoed during KII by a district education officer for primary school education from Mbulu district who said: "Yes, I was taught in Primary school, it is a flatworm with segments (KII, Mbulu district 17/12/2018)."

This was further echoed by FGDs from primary and secondary school teachers in one of the villages in Mpwapwa, who said:

"What we know is that when they enter the human body, they stay in the small intestine and absorb nutrients, and they have segments that detach and get out with faeces" (KII, Mpwapwa district, 18/02/2019).

The knowledge regarding tapeworm transmission was echoed during KIIs, as exemplified by the following quotations:

"I have also heard from our livestock extension officer that the human consumption of undercooked meat infected with *T. solium* can cause the disease and that humans can

also be infected through drinking contaminated unboiled water (KII, Mbulu district, 17/12/2018)."

"Tapeworm can be transmitted through improperly cooked pork (KII, Mpwapwa district, 18/02/2019)."

On the other hand, low knowledge of the transmission of the tapeworm was also noted: "I don't know the transmission of tapeworm to a human being" (KII, Mpwapwa district, 18/02/2019)."

FGD participants with VHC at Masieda village in Mbulu district agreed that they did not know how tapeworm is transmitted to human beings. On the other hand, FGD participants with VHC at Mpuguso village in Rungwe district revealed that they had heard that tapeworm could be transmitted through eating improperly cooked pork, especially roasted meat, as it does not cook well. These are surprising findings as the former village had received health education on TSCT approximately 15 years ago, while we have no knowledge of the latter district being educated on this.

Mpwapwa district respondents, OR 18.766 (95% CI: 2.189-160.890, $P = 0.0075$), were 18.766 times more likely to be aware of the health effect of a tapeworm on humans compared to Rungwe district respondents. Mpwapwa district respondents OR 2.482 (95% CI: 1.214-5.071, $P = 0.0127$) were 2.482 times more likely to be at risk of tapeworm infection than Rungwe district (Table 1).

These results were further confirmed during KIIs. For example, the following statement was captured:

"Eating infected pork may lead to the development of adult tapeworm and may later lead to mental and growth retardation to under-five children, as well as anaemia and malnutrition" (Medical doctor, 18/02/2019)."

The influence of locations on the knowledge regarding tapeworm/taeniasis could also be linked to the economic status and activities of the

population from the study districts, as well as different government interventions on deworming, as narrated by one of the health-care KIIs.

"We also have a campaign for Neglected Tropical Diseases (NTD) where, after every 6 months, we administer praziquantel, albendazole, and erythromycin; this is a national campaign where we are required to administer those drugs every 6 months" (KII, Mpwapwa district, 18/02/2019)."

Respondents with post-primary education, OR 13.267 (95% CI: 0.860-204.611, $P = 0.0640$) were 13.3 times more likely to be aware of the HCC transmission mode than those with no formal education, although the P-value was not statistically significant (see Table 2). Respondents with primary school education OR 0.749 (95% CI: 0.057- 9.771, $P = 0.8256$) were 0.749 times less likely to be aware of the health effect of HCC compared to those with no formal education, although the P-value was not statistically significant (see Table 2). Respondents with post-primary education, OR 62.231 (95% CI: 3.909-990.744, $P = 0.0034$) were 62.231 times more likely to be aware of the health effects of HCC compared to those with no formal education (Table 3). It was further revealed by a village leader in Mpwapwa district who said:

"Here, people with low knowledge eat pork with the cysticerci, even when meat inspectors have ordered condemnation" (KII, Mpwapwa district, Village leader 18/02/2019)."

Respondents from Mbulu district OR 3.034 (95% CI: 1.225-7.513, $P = 0.0165$) were 3.034 times more likely to be aware of the risk of eating infected pork than those from Rungwe District (see Table 4). While Mpwapwa district respondents OR 1.978 (95% CI: 0.134-0.866, $P = 0.0237$) were 1.978 times less likely to be able to identify cysticerci in infected pork than those from Rungwe district (see Table 5). Male respondents OR 2.106 (95% CI: 1.150-3.855, $P = 0.0158$) were 2.106 times more likely to identify cysts than female respondents. Respondents with

more than 10 years of residents in the village OR infected pork than those with <5 years of residents 4.682 (95% CI: 1.803-12.160, $P = 0.0015$) were (Table 5).
4.682 times more likely to identify cysticerci in

Table 2: Knowledge of human cysticercosis transmission (n = 483)

Independent variables	B	SE.	Wald χ^2	p-value	ORs
Intercept	-15.7961	174.1	0.0082	0.9277	-
Primary education	-0.2887	1.3103	0.0485*	0.8256	0.749
Post-primary education	2.5853	1.3958	3.4305	0.0640	13.267
Mbulu district	12.1131	174.1	0.0048*	0.9445	0.670
Mpwapwa district	15.7553	174.1	0.0082*	0.9279	257.307
Mbinga district	10.0729	174.1	0.0033*	0.9539	0.001

Note: Wald $\chi^2(5) = 17.4327$, Prob < 0.0037, significant at $P \leq 0.05$, c-statistic=92%, H-L ($p = 0.9462$). The dependent variable in this analysis is the knowledge of HCC transmission and coded so that 0 = no and 1 = yes.

Table 3: Knowledge of human cysticercosis health effect (483)

Independent variables	B	SE.	Wald χ^2	p-value	ORs
Intercept	-2.0261	1.3831	2.1461	0.1429	-
Primary school education	2.3138	1.2733	3.3023	0.0692	10.113
Post-primary education	4.1309	1.4121	8.5579	0.0034*	62.231
Mbulu district	-1.7429	0.6188	7.9329	0.0049	0.175
Mpwapwa district	2.0808	1.3700	2.3067	0.1288	8.011
Mbinga district	-1.2824	1.6377	0.6131	0.4336	8.011

Note: Wald $\chi^2(5) = 21.1689$, Prob = 0.0008, significant at $P < 0.05$, c-statistic=78%, H-L ($p = 0.8881$). The dependent variable in this analysis is the knowledge of the HCC health effect and, coded so that 0 = no and 1 = yes.

Table 4: Knowledge of the risk of eating infected pork (n = 483)

Independent variables	B	SE.	Wald χ^2	p-value	ORs
Intercept	-2.7903	0.3894	51.3471	<0.0001*	-
Mbulu district	1.1098	0.4627	5.7532	0.0165 *	3.034
Mpwapwa district	0.6731	0.4877	1.9052	0.1675	1.960
Mbinga district	-0.5683	0.6406	0.7872	0.3749	0.566

Note: Wald $\chi^2(3) = 11.8671$, Prob = 0.0079, significant at $P < 0.05$, c-statistic=66%, H-L ($p = 1.000$). The dependent variable in this analysis is the awareness of the risk of eating infected pork and, coded so that 0 = no and 1 = yes.

Table 5: Knowledge of respondents on identifying cysticercosis in pork (n = 483)

Independent variables	B	SE.	Wald χ^2	p-value	ORs
Intercept	0.8757	0.6664	1.7267	0.1888	-
Mbulu district	0.3394	0.5399	0.3952	0.5296	1.404
Mpwapwa district	-1.0755	0.4754	5.1191	0.0237*	1.978
Mbinga district	-1.5745	0.4633	11.5485	0.0007*	4.891
Sex (male)	0.7447	0.3085	5.8260	0.0158 *	2.106
Age group 16-35 years	-0.7662	0.4325	3.1387	0.0765	0.465
Age group 36-55 years	0.1828	0.4290	0.1816	0.6700	1.201
Period of residence (6-10 years)	0.4762	0.7160	0.4423	0.5060	1.610
Period of residence (>10 years)	1.5437	0.4870	10.0485	0.0015*	4.682

Note: Wald $\chi^2(8) = 45.8532$, Prob < 0.0001, significant at $P < 0.05$, c-statistic=77%, H-L ($p = 0.2018$). The dependent variable in this analysis is the knowledge of respondents on identifying cysticerci in pork and coded so that 0 = no and 1 = yes.

Odds ratios (ORs) were estimated using the maximum likelihood method.

*Statistically significant at $P < 0.05$; H-L = Hosmer and Lemeshow Test

Knowledge of Porcine Cysticercosis (PCC) that was Assessed Using Binary Logistic Regression

Respondents from Mbulu district OR 4.561 (95% CI: 2.495-8.337, $P < 0.0001$) were 4.561 times more likely to be aware of PCC transmission compared to those from Rungwe district. Respondents from Mbinga district OR 0.344 (95% CI: 0.166-0.712, $P = 0.0040$) were 0.344 times less likely to be aware of PCC transmission measures. While respondents from Mbinga

district OR 5.877 ($P < 0.0001$), were 5.877 times more likely to be aware of the PCC control measures compared to those from Rungwe district. The respondents lived in their respective villages for more than ten years, OR 4.682 (95% CI: 1.138-4.785, $P = 0.0207$), were 4.682 times more likely to be aware of the PCC health effect compared to those from Rungwe district (Table 6).

Table 6: Binary logistic regression analysis of knowledge on porcine cysticercosis (PCC)

Independent variables	B	SE.	Wald χ^2	p-value	ORs
Knowledge of porcine cysticercosis transmission methods					
Intercept	-1.875	0.2972	39.7961	<.0001	-
SACCOS membership	0.6133	0.2919	4.4138	0.0356	1.846
Mbulu district	1.5175	0.3077	24.3138	<.0001*	4.561
Mpwapwa district	0.9341	0.2998	9.7102	0.0018*	2.545
Mbinga district	-1.0661	0.3708	8.2667	0.0040*	0.344
Sex	0.8842	0.219	16.3069	<.0001*	2.421
<i>Note: Wald chi2 (5) = 58.3861, Prob < 0.0001, significant at $P < 0.05$, c-statistic=72%, H-L (p = 0.4761). The dependent variable in this analysis is PCC transmission methods and coded so that 0 = no and 1 = yes.</i>					
Knowledge of porcine cysticercosis control measures (PCC)					
Intercept	-0.462	0.4158	1.2348	0.2665	-
Livestock keeping	-0.1561	0.4977	0.0984	0.7537	0.855
Farming and livestock-keeping	0.9972	0.4127	5.839	0.0157*	2.711
Mbulu district	-1.137	0.2747	17.1333	<.0001*	0.321
Mpwapwa district	0.8611	0.2895	8.8468	0.0029*	2.366
Mbinga district	1.7711	0.3547	24.93	<.0001*	5.877
<i>Note: Wald chi2 (5) = 18.3285, Prob 0.0026, significant at $P < 0.05$, c-test = 61%, H-L (p = 0.7663). The dependent variable in this analysis is PCC control measures and coded so that 0 = no and 1 = yes.</i>					
Knowledge of porcine cysticercosis health effect					
Intercept	-0.2045	0.3817	0.2869	0.5922	-
Sex (male)	0.3856	0.1949	3.9132	0.0479*	2.106
Age group 16-35 years	-0.7662	0.4325	3.1387	0.0497*	0.465
Age group 36-55 years	0.1828	0.429	0.1816	0.67	1.201
Period of residence (6-10 years)	0.4762	0.716	0.4423	0.506	1.61
Period of residence (>10 years)	1.5437	0.487	10.0485	0.0207*	4.682
<i>Note: Wald chi2 (3) = 28.2239, Prob < 0.0001, significant at $P < 0.05$, c-test = 67%, H-L (p = 1). The dependent variable in this analysis is the PCC health effect coded so that 0 = no and 1 = yes.</i>					
<i>Odd ratios (ORs) were estimated using the maximum likelihood method.</i>					
<i>*Statistically significant at $P < 0.05$; H-L = Hosmer and Lemeshow Test</i>					

Attitude Related to TSCT as Reported by Respondents in the Study Districts

Regarding the respondent's attitude of being at risk of acquiring tapeworm, respondents from Mbulu district, OR 0.514 (95% CI: 0.205-1.289, $P = 0.1561$), were 0.514 times less likely to be aware of being at risk of acquiring tapeworm compared to respondents from Rungwe district. Respondents from Mpwapwa district, OR 2.561

(95% CI: 1.113-5.892, $P = 0.0269$), were 2.561 times more likely to be aware of being at risk of acquiring tapeworm compared to those from Rungwe district. The respondents from the Mbinga district, OR 3.312 (95% CI: 1.364-8.040, $P = 0.0081$), were 3.312 times more likely to be aware of being at risk of acquiring tapeworm compared to those from Rungwe district (Table 7).

Table 7: Attitude related to TSCT as reported by respondents in the study districts

Independent variables	B	SE.	Wald χ^2	p-value	ORs
The attitude of being at risk of acquiring tapeworm					
Intercept	-0.869	0.3304	6.9172	0.0085*	-
Mbulu district	-0.6649	0.4687	2.0121	0.1561	0.514
Mpwapwa district	0.9405	0.4251	4.895	0.0269*	2.561
Mbinga district	1.1975	0.4525	7.0046	0.0081*	3.312
<i>Note: Wald chi2 (3) = 22.3081, Prob<0.0001, *significant at P< 0.05, c-test=69.3%, H-L (p = 0.8218). The dependent variable in this analysis is at risk of acquiring tapeworm and coded so that 0 = negative attitude and 1 = positive attitude.</i>					
The attitude of being at risk of acquiring HCC					
Intercept	-2.5649	1.0377	6.109	0.0134*	-
Mbulu district	0.5281	1.1249	0.2204	0.6387	1.696
Mpwapwa district	1.0609	1.1758	0.8141	0.3669	2.889
Mbinga district	2.6827	1.1459	5.4812	0.0192*	14.625
<i>Note: Wald chi2 (3) = 13.0130, Prob<0.0046, *significant at P< 0.05, c-test 72%, H-L (p = 0.8894). The dependent variable in this analysis is at risk of acquiring HCC and coded so that 0 = negative attitude and 1 = positive attitude.</i>					
The attitude of whether it is safe to eat pork infected with cysticerci					
Intercept	-3.3586	0.5086	43.6051	<.0001*	-
Mbulu district	1.6781	0.5667	8.7691	0.0031*	5.355
Mpwapwa district	1.2415	0.5873	4.4689	0.0345*	3.461
Mbinga district	0.5683	0.6406	0.7872	0.3749	1.765
<i>Note: Wald chi2 (3) = 11.8671, Prob = 0.0079, *significant at P< 0.05, c-test=66.1%, H-L (p = 0.8914). The dependent variable in this analysis is if it is safe to eat pork infected with cysticerci and coded so that 0 = negative attitude and 1 = positive attitude.</i>					
<i>Odd ratios (ORs) were estimated using the maximum likelihood method.</i>					
<i>*Statistically significant at P< 0.05.</i>					
<i>H-L = Hosmer and Lemeshow Test</i>					

The qualitative data further confirmed the results from the household survey as echoed by one of the community development officers during IDI, who said: “We are at risk as it may come from eating undercooked infected pig meat” (KII, Mbulu district 17/12/2018).

The risk of acquiring tapeworm was also realised during FGD with science subject teachers from one of the wards in Mpwapwa district, with the group agreeing that those who allow their pigs to roam free subject the pigs to free open defecation around the village, which is a risk factor for PCC and hence to Tapeworm infection to human being (FGD, Mpwapwa district 17/02/2019).

Respondents from Mbinga district, OR 14.625 (312 (95% CI: 1.364-8.040, $P = 0.0192$) were 14.625 times more likely to be aware of the risk of acquiring HCC compared to those from Rungwe district (Table 7).

Qualitative data were further confirmed during KIIs as quoted from this statement from the headmaster of one of the secondary schools confirming that students are at school while in school.

“I think they are at risk because we are using tap water, which is not 100% safe; when they are in school, they drink untreated water, though sometimes we treat the water with chlorine in the reservoir tank, but it is not always” (KII, Mpwapwa district 18/02/2019).

This was also echoed by one of the ward education officers from Mbulu district who remarked: “One of the risk factors is water; water they are using in surroundings is not safe, and this can lead to intestinal worm infection in one or another way” (KII, Mbulu district 17/12/2018).

The risk of acquiring HCC was also realised during FGDs with science subject teachers from

one of the wards in Rungwe district, with the group agreeing that: Although they put clean and safe water in a large bucket for students to drink, some of them still drink water from the trench that flows from the river" (FGD, Rungwe district 14/06/2019). This was also agreed during FGDs with science subject teachers in Mbulu districts, where a group agreed that:

"Students are at risk of acquiring HCC the school environment is not friendly at all, for example, most children when visiting toilets, they don't wash their hands, and some are using papers other are using water to clean their private parts" (FGD, Mbulu district 17/12/2018).

While respondents from Mbulu, OR 5.355 (95% CI: 1.764-16.261, $P = 0.0031$) and those from Mpwapwa district, OR 3.461 (95% CI: 1.095-10.940, $P = 0.0345$) were 5.355 and 3.461 times more likely to be aware that it is not safe to eat infected pork and instead it should be condemned compared to those from Rungwe district (Table 7).

These results were further confirmed by qualitative data, as echoed during KII by the headmaster of one of the secondary schools from Mpwapwa district.

"I remember once LFO condemned the pig meat in Chimaza village and told villagers that the meat is not safe, but they dig out and eat that meat; I think two children died, villagers believe that the deaths were caused by witchcraft" (KII, Mpwapwa district 17/02/2019)

This was further realised during FGDs with a village health committee from one of the villages in Mpwapwa district, with the group agreeing that:

"Pig meat from the slaughter slab is usually inspected and confirmed to be safe for human consumption. But if the meat is not from the slaughter slab and it was not inspected and

confirmed to be safe by the Livestock extension officer, I can't eat that meat (FGD, Mpwapwa district 18/02/2019).

Practices Related to TSCT as Reported by Respondents in the Study Districts

Regarding the practice of washing hands with soap after defecation, respondents with post-primary education, OR 6.589 (95% CI: 2.691-16.131, $P < 0.0001$), and primary school education, OR 4.117 (95% CI: 2.150-7.883, $P < 0.0001$) were 6.589 and 4.117 times more likely to report washing their hands with soap respectively compared to those with no formal education. While the respondents keeping livestock, OR 0.193 (95% CI: 0.056-0.666, $P = 0.0092$) and those engaged in farming and livestock keeping, OR 0.288 (95% CI: 0.096-0.864, $P = 0.0264$) were 0.193 and 0.288 times less likely to wash their hands with soap respectively than those engaged in livestock keeping and business (Table 8).

Concerning the practices of hand washing with soap before eating, male respondents, OR 1.838 (95% CI: 1.223-2.762, $P = 0.0034$), were 1.838 times more likely to wash their hands than female respondents. Respondents with post-primary education, OR 6.118 (95% CI: 2.384-15.698, $P = 0.0002$), and those with primary school education, OR 4.764 (95% CI: 2.278-9.962, $P < 0.0001$) were 6.118 and 4.764 times more likely to wash their hands respectively before eating than those with no formal education. And those from Mpwapwa district, OR 3.802 (95% CI: 2.114-6.839, $P < 0.0001$), were 3.802 times more likely to wash their hands than those from Rungwe district (Table 8).

Regarding the treatment of drinking water, respondents in Mbulu district, OR 0.477 (95% CI: 0.278-0.820, $P = 0.0073$), and Mpwapwa district OR, 0.433 ($P = 0.0027$), were 0.447 and 0.433 times less likely to treat drinking water respectively comparing to those from Rungwe district (Table 8).

Table 8: Practices related to TSCT as reported by respondents in the study districts

Independent variables	B	SE.	Wald χ^2	p-value	ORs
Practice washing hands with soap after defecation					
Intercept	0.7113	0.6308	1.2718	0.2594	-
Primary school education	1.4150	0.3315	18.2237	<0.0001*	4.117
Post-primary education	1.8854	0.4568	17.0342	<0.0001*	6.589
Livestock keeping	-1.6438	0.6311	6.7851	0.0092*	0.193
Farming and livestock-keeping	-1.2460	0.5610	4.9323	0.0264*	0.288
SACCOS membership	-0.6194	0.2170	8.1454	0.0043*	0.538
<i>Note: Wald χ^2 (5) = 32.7891, Prob=0.0001, *significant at $P < 0.05$, c-test=64%, H-L (p = 0.8218). The dependent variable in this analysis is washing hands with soap after defecation and coded so that 0 = No and 1 = Yes.</i>					
Practice of washing hands with soap before eating					
Intercept	-0.3953	0.7011	0.3179	0.5729	-
Mbulu district	0.8775	0.2934	8.9459	0.0028*	2.405
Mpwapwa district	1.3356	0.2995	19.8816	<0.0001*	3.802
Mbinga district	0.1464	0.2910	0.2532	0.6148	1.158
Primary school education	1.5612	0.3764	17.2062	<0.0001*	4.764
Post-primary education	1.8112	0.4808	14.1898	0.0002*	6.118
Sex	0.6086	0.2078	8.5782	0.0034*	1.838
SACCOS membership	-0.6788	0.2595	6.8428	0.0089*	0.507
Livestock keeping	-1.9815	0.6413	9.5462	0.0020*	0.138
Farming and livestock-keeping	-1.7311	0.5632	9.4483	0.0021*	0.177
<i>Note: Wald χ^2 (9) = 67.0543, $P < 0.0001$, *significant at $P < 0.05$, c-statistic = 73%, H-L (0.5804). The dependent variable in this analysis is washing hands with soap before eating and coded so that 0 = no and 1 = yes.</i>					
Practice of treatment of drinking water					
Intercept	-0.2829	0.1836	2.3726	0.1235	-
Mbulu	-0.7400	0.2761	7.1862	0.0073*	0.477
Mpwapwa	-0.8377	0.2792	9.0058	0.0027*	0.433
Mbinga	-0.0048	0.2608	0.0003	0.9853	0.995
<i>Note: Wald χ^2 (3) = 16.0666, $P = 0.0011$, *significant at $P < 0.05$, c-statistics=60%, H-L (p = 1). The dependent variable in this analysis is the treatment of drinking water coded so that 0 = No and 1 = Yes</i>					
The practice of pig rearing system					
Intercept	-0.2283	0.4631	0.2430	0.6220	-
Mbulu district	-2.3426	0.3120	56.3766	<.0001*	0.033
Mpwapwa district	0.4336	0.3525	1.5127	0.3102	0.219
Mbinga district	0.3172	0.3415	0.8626	0.3530	1.373
Livestock keeping	-2.6342	0.7041	13.9978	0.0002*	0.072
Farming and livestock-keeping	1.5496	0.4148	13.9566	0.0002*	4.710
<i>Note: Wald χ^2 (5) = 126.5137, $P < 0.0001$, *significant at $P < 0.05$, c-statistic = 81%, H-L (0.9576). The dependent variable in this analysis is the pig rearing system coded so that 0 = free range and 1 = confinement/tethering</i>					
<i>Odd ratios (ORs) were estimated using the maximum likelihood method.</i>					
<i>*Statistically significant at $P < 0.05$; H-L = Hosmer and Lemeshow Test</i>					

This was also echoed by an academic staff of one of the secondary schools in Mpwapwa district during a KII session who remarked:

“During the tea break, we have people selling bites at school and, since we do not have running water, when students are hungry, they buy and eat buns without washing their

hands; this puts them at risk of intestinal worm infection.” (KII, Mpwapwa district, 18/02/2019).”

This was further confirmed by a livestock field officer during a KII in one of the villages in Mpwapwa district:

“During the rainy season, major diseases are amoeba and cholera; this is due to the reason that many people do not use toilets and also don't wash their hands after visiting toilets and before eating” (KII, Mpwapwa district, 18/02/2019).”

The importance of washing hands was realised during FGDs with science subject teachers from one of the wards in Mbulu district, with the group agreeing that: “if one visits the toilet, she/he should wash hands with soap and should not put hands in the mouth before they are washed”.

Qualitative data confirmed these findings in terms of the treatment of drinking water, as illustrated by the following quote from one of the district officials in Mbulu district.

“Humans can also become infected through drinking contaminated untreated water; usually water is contaminated by T. solium eggs through practising open defecation; all these can lead to human beings becoming infected with epilepsy and visual impairment, leading to blindness” (KII, Mbulu district, 17/12/2018).”

DISCUSSION

The limited general knowledge, attitudes, and good practices may obstruct efforts to control and eliminate TSCT. The findings from this study revealed that the majority of the respondents were aware of PCC, with about 50% being specifically aware of *T. solium*. On the other hand, very few were aware of HCC. Education level and district of residence were the main factors that influenced KAP relevant for the control of TSCT as they were found to influence most of the aspects assessed. Respondents with tertiary education were more likely to have heard of tapeworm, be aware of tapeworm transmission, HCC transmission, HCC health effects, wash hands with soap after toilet use, and treat drinking water compared to those with no formal education. The results are comparable to those reported in Kenya, where an increase in participants' education increased understanding of the relationship between epilepsy and *T. solium* (Wohlgemut et

al., 2010). Similar observations have been reported the influence of education on hand-washing practise Pedro et al. (2008). Also, it was observed that education alone could directly influence an individual's ability to recognise and take action towards disease preventive measures (Yuan et al., 2005).

The respondents in Mpwapwa and Mbulu districts had better knowledge of many aspects of TSCT than other districts, while respondents in Mbulu district reported poor practices in more aspects than the rest of the districts. Respondents from Rungwe district had a positive attitude towards the risk of tapeworm infection and being at risk of HCC while having the negative attitude that it is safe to consume infected pork compared to the other two districts. The influence of location on the KAP regarding TSCT is not known and may be linked to activities of the population from the study districts, as well as different government interventions such as the National Campaign for the Neglected Tropical Diseases (NTD). For example, a National campaign for the eradication of schistosomiasis in Tanzania through a mass drug administration (MDA) campaign of praziquantel was reported to have an effect on the prevalence of taeniasis and PCC (Braae et al., 2016).

The results from this study revealed that males were more likely to identify the cysticerci in pork and tell the health effects of HCC transmission PCC transmission. Also, are reported to exercise hand washing with soap before eating compared to female respondents. Most males are responsible for pig slaughtering and selling pork; probably, this exposes them to information regarding TSCT compared to women. It could also be because women are particularly disadvantaged due to the social and economic priority granted by the wider society to men, sometimes not allowed to participate in various social activities involving men and schooling. The results are contrary to other studies that reported that females were slightly more likely to wash their hands than males (Pete, 1986) and that women wash their hands more frequently than males (Edwards et al., 2002). This contradiction may be due to the fact

that the two studies cited above actually observed the hand washing practice, compared to this study, which relies only on a questionnaire survey, KII, and FGD.

This study revealed that age was associated with knowledge regarding TSCT, as young respondents between 16-35 years old and between 36-55 were less likely to identify cysticerci in pork compared to people >55 years old. This may be because older people have more exposure and attend more training regarding TSCT and other hygienic practices than young respondents.

This study revealed that occupation could also influence KAP regarding TSCT. Respondents who were farming and keeping pigs were more likely to know PCC control measures, less likely to report washing hands with soap after toilet use, and more likely to report confining their pigs compared to those engaged in both pig keeping and other businesses. This is likely the case because those engaged in more than one business are interacting with people from other villages and sometimes travel far from their village for business; this gives them more access to information than those keeping livestock or keeping livestock and farming as sole occupation. It was also found that respondents keeping livestock were less likely to report washing their hands with soap before eating compared to those engaged in both livestock keeping and other businesses. This may be due to the exposure those doing other businesses (in addition to keeping pigs) had over those keeping livestock only. It is also possible that those engaged in other businesses had sound financial resources regularly to enable them to afford to acquire water and soap for cleaning and sanitation, among other good practices.

CONCLUSION

The study reveals that socio-demographic factors may influence knowledge, attitude, and practices regarding TSCT control. Education level was the main factor, among others, that significantly contributed to the overall models that determined knowledge, attitude, and practices towards TSCT control. It is, therefore, necessary to scale up the

efforts in knowledge sharing with the public on transmission, TSCT signs/symptoms, control, treatment and prevention in Tanzania, preferably in a One Health approach, for the control and eradication of TSCT. The findings from this study may influence the design of health education packages that may help reach some of the goals specified in the WHO roadmap for neglected tropical diseases 2021–2030. It is further recommended that strategies involving health education intervention should consider the inclusion of socio-demographic, cultural, economic, and location factors for effective and sustainable control of the parasite.

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CHAPTER FOUR

4.0 Development and rapid assessment of Community-Based Health Education Package for the Control of *Taenia solium* taeniasis/cysticercosis in Tanzania

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4.1 Abstract

The study was conducted to develop and rapidly assess a community-based health education package (CHEP) to serve as a guide to improving knowledge, and practices) for controlling *Taenia solium* cysticercosis Taeniasis (TSCT) in endemic areas in Tanzania. For the development of the (CHEP) data was collected through a questionnaire and observation of household infrastructure. For triangulation, a total of 14 FGDs were conducted and 12 were included in the analysis, two were of poor quality as the audio could not be heard clearly and failed to be transcribed, 38 key informant interviews (KIIs) were also conducted and analysed using ATLAS.ti 8. A household survey using a questionnaire was conducted on 483 respondents and analysed using SPSS by conducting a chi-square test. Data from the rapid assessment of CHEP was collected through a questionnaire and analysed using SPSS software by running a chi-square test. The developed CHEP included the following key messages: (1) improving knowledge and attitudes towards TSCT transmission, causes, health effects, treatment, and control measures, (2) proper pork preparation and general food handling practices, (3) good pig husbandry practices, and (4) improving water, sanitation, and hygiene (WASH) practices. The CHEP developed consists of a Training of Trainers (TOT) manual, a leaflet/brochure, a poster, and a handbook. The results from the rapid assessment reported a statistically significant improvement in knowledge regarding the link between epilepsy and cysticercosis ($p < 0.001$) and in the practice of washing fruits and vegetables ($p = 0.025$). Although a non-statistically significant improvement was noticed in the rest of the variables in both knowledge and practices in all three groups. Therefore, it is recommended that one health approach toward the implementation of CHEP in areas affected by TSCT be conducted by key stakeholders for the control of the disease.

Keywords: *Taenia solium*, cysticercosis, health education package; Tanzania.

4.2 Introduction

There are 2.4 million pigs in Tanzania, with a total of 9% of Tanzanian households keeping livestock (URT, 2015). Pig farming makes an important contribution to income generation, food security, soil fertility improvement, asset storage, and intangible functions that are not linked to economic gains in the communities (Kimbi *et al.*, 2015). Free-ranging pigs are exposed to infection by parasites such as *Taenia solium*, which has a negative impact on profits through the condemnation of infected carcasses and the zoonotic risk of the parasite. The parasite causes TSCT in humans (Roesel *et al.*, 2017). The societal cost of TSCT in endemic communities is extremely high; in Tanzania, it has been reported to be USD 8 million annually (Trevisan *et al.*, 2017). The costs consist of economic loss due to the decline in the market

value of infected pork, condemnation of infected pork, diagnosis and treatment of human cases, and the severe impact on farmers' livelihoods (Atawalna and Mensah, 2015). An increase in the prevalence of porcine cysticercosis (PCC) in the Eastern and Southern Africa (ESA) region has been linked to the increase in smallholder pig farming and pork consumption (Phiri *et al.*, 2003). Therefore, it is recommended that one health approach toward the implementation of CHEP in areas affected by TSCT be conducted by key stakeholders for the control of the disease.

TSCT affects more than 50 million people worldwide and leads to the death of about 50,000 people annually (WHO, 2013). The main obstacle to effective control of cysticercosis is the low knowledge of the transmission of the parasite (Johansen *et al.*, 2014). Health education plays an important role in the prevention and control of infectious diseases (Alexander *et al.*, 2012; Johansen *et al.*, 2014; Ngowi *et al.*, 2017). In some communities, various health education interventions have been implemented.

In some communities, various control strategies have been implemented to control TSCT. These strategies include the use and proper maintenance of latrines (Braae *et al.*, 2015; Ngowi *et al.*, 2017), treatment of taeniasis cases with praziquantel or niclosamide (Bustos *et al.*, 2012), treatment of porcine cysticercosis with oxfendazole (Mkupasi *et al.*, 2013), vaccination of pigs (Kabululu *et al.*, 2020; Lightowlers, 2013) and confinement of pigs. Measures also focused on the immediate removal of children's faeces in latrines, thorough hand washing with soap/detergents, boiling of drinking water, prohibition of consumption or sale of infected pork, and improved meat inspection. The effectiveness of the measures was either low or short-lived, and other strategies were too expensive to apply on a large scale (Braae *et al.*, 2014; Carabin and Traoré, 2014; Kabululu *et al.*, 2020; Mkupasi *et al.*, 2013; Ngowi *et al.*, 2004, 2008).

Despite control measures, the disease is still widespread in many pig farming areas in Tanzania. One of the reasons for the endemicity is the lack of knowledge about TSCT in rural communities. Most of them practice free-range pig farming under poor hygienic conditions (Carabin and Traoré, 2014; Shonyela *et al.*, 2017). For effective and sustainable control of the parasite, a One Health approach is the way to go (Braae *et al.*, 2016; García *et al.*, 2007; Okello and Thomas, 2017; Ramiandrasoa *et al.*, 2020).

Health education in endemic regions is crucial for an effective and sustainable control programme to improve the health and economic situation of the infected population (Alexander *et al.*, 2012; Mwidunda *et al.*, 2015; Ngowi *et al.*, 2017; Sarti *et al.*, 1997). Long-term change can only be successful if health education programmes are accompanied by community participation (Alexander *et al.*, 2012; Mwidunda *et al.*, 2015; Ngowi *et al.*,

2017; Sarti *et al.*, 1997). In the health education studies conducted in Tanzania, the target groups were not fully involved in the process from planning/development to implementation and evaluation (Mwidunda *et al.*, 2015; Ngowi *et al.*, 2008, 2011). Therefore, there was a need to develop a community-based health education package (CHEP) that fully involves the communities.

The community-based health education package (CHEP) developed and rapidly assessed is a conventional education approach aimed at improving community knowledge, and practices in controlling TSCT. The health education package was developed based on information obtained from the community in four districts in Tanzania, namely Mbulu, Mpwapwa, Mbinga, and Rungwe, on their knowledge and practices regarding TSCT control. The package was rapidly assessed through education intervention in Babati district. Poor knowledge and practices were reported in this study as well as in studies from India, Mexico, and Tanzania (Alexander *et al.*, 2012; Ngowi *et al.*, 2008; Sarti *et al.*, 1997). It was, therefore, necessary to develop this structured CHEP to improve KAP, which in turn will lead to behaviour change believed to be fundamental to controlling TSCT. The CHEP was developed with community involvement from planning through development and implementation to evaluation/assessment. The CHEP consists of four components, namely a Training of Trainers (TOT) manual, posters, brochures, and a manual with illustrations (pictures) on critical TSCT control strategies. It is expected that the package will be integrated with other existing TSCT control strategies.

It is assumed that the CHEP developed can be easily adapted and implemented by communities in resource-poor endemic countries. This paper describes the development and rapid assessment of the community-based health education package for TSCT control in Tanzania.

4.3 Methodology

4.3.1 Study area

The information used to develop this CHEP was collected from communities in Mbulu, Mpwapwa, Mbinga, and Rungwe districts in four different agro-ecological zones in Tanzania (Nyangi *et al.*, 2022). The main criterias for the selection of the Districts were (i) being endemic for PCC, (ii) being popular for small scale pig rearing, and for (iii) representing different agro-ecological zones, socio-economic and cultural factors. The rapid assessment of the CHEP was conducted in two villages of Babati district.

4.3.2 Study design

A cross-sectional survey was conducted in eight purposively selected villages in the four study districts based on the criteria that they should have at least 45 households that are keeping pigs. In developing the CHEP, the guidelines

were adopted with minor modifications (Alexander *et al.*, 2012; CDC, 2013; Ngowi *et al.*, 2008; Sarti *et al.*, 1997). The development of the health education package was done in three main steps: (i) formative research (Figure 1) (ii) development of the health education package (iii) pilot test and revision (Figure 2). The rapid assessment was conducted between September and October 2021 in two selected villages from the purposely selected Babati district. The district was selected for being endemic for porcine cysticercosis (PCC) and popular for small-scale pig-keeping.

4.3.3 Selection of households

For the development of CHEP, a total of 483 households from the eight sampled villages were selected using a simple random sampling method). For the rapid assessment, 15 pig farmers and 15 non-pig farmers were randomly selected, as well as 15 government officials and 5 pig butcher/pig traders to attend a one-day workshop on the rapid assessment of the developed CHEP. This makes a total of 50 participants per village during pre-intervention and 50 during post-intervention. One week before the workshop; a list of all smallholder pig-keeping and non-pig farmers' households were selected from the village list with the help of local village leaders, the ward livestock field officers, and the ward executive officers (WEO).

4.3.4 Formative research

An assessment of the local context and risk factors for TSCT infection in the target community was conducted using a formative research guide (Fig. 4.1). Formative research is a process in which researchers identify a target community for study, decide how to access that community, and define the community characteristics that are important to a particular public health problem (CDC, 2013).

For this study, the risk factor was defined as: An aspect of personal behaviour or lifestyle, environmental exposure, or inherited characteristic that epidemiological evidence has linked to one or more preventable health condition(s) (Skolnik, 2016).

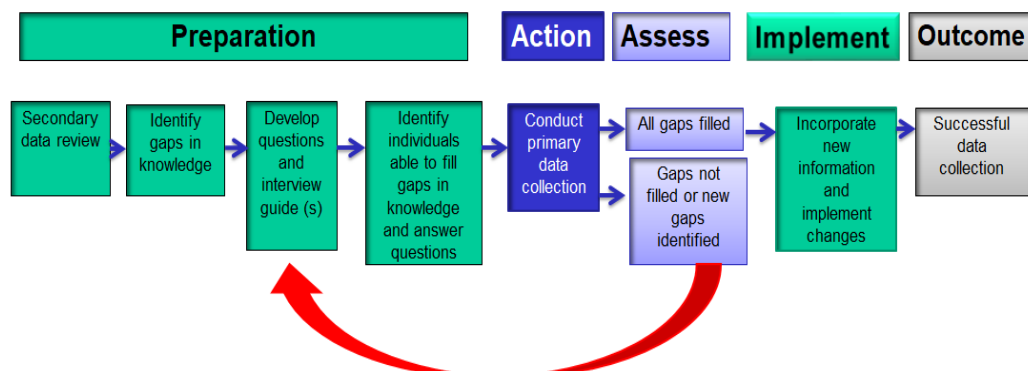


Figure 4.1: The iterative process of formative research, adapted from CDC

(Source: CDC, 2013).

4.4 Data Collection

A community-based mixed-methods approach was used for the study, which included inputs from the household survey of pig farmers and non-pig farmers, and interviews with key informants (KIs), i.e., primary and secondary school headmasters, veterinary officers, health officers, environment and sanitation officers, community development officers and education officers at the community and district levels using a key informant interview guide. Focus group discussions (FGDs) were also conducted with the village health committee and primary and secondary school teachers to identify potential TSCT infection risks in the study area. Household infrastructure was also observed using an observation checklist in the same household that had participated in the household survey. The information collected led to the formulation of key messages for the development of a health education package.

Both qualitative and quantitative approaches were used for triangulation to validate the research findings through the use of multiple data collection methods (CDC, 2013). One way to triangulate data from formative research is to compare information on the same topic from different data sources. Another strategy is to use at least two different data collection methods such as KIs, FGDs, and household observations (CDC, 2013). Data to assess risk factors reflecting the natural and human environment, such as TSCT transmission and behaviours conducive to TSCT transmission, were collected through a household survey using semi-structured questionnaires and a household infrastructure observation checklist (Nyangi *et al.*, 2022). For FGDs, KIs refer to chapter 3 of this thesis (Nyangi *et al.*, 2024).

For the rapid assessment, the farmer's workshop began with a questionnaire intended to identify farmers' knowledge and practices regarding *Taenia solium* life cycle, knowledge of signs of human infection of *Taenia solium*, the transmission of taeniasis and neurocysticercosis, the transmission of porcine cysticercosis, methods of pig keeping, and personal hygiene habits likely to affect the transmission of *Taenia solium* eggs from either pigs or people as well as recognition of tapeworm segments in stool. Farmers were also asked to describe what proportion of time they kept their pig tethered during the harvest, planting, and growing seasons of the year and whether the family is always using a latrine for defecation, always washing hands with soap after defecating and before eating, and always washing fruits and vegetables. The administration of the questionnaire was followed by a workshop where health education intervention was conducted.

4.4.1 Household survey

The household survey was conducted using a structured questionnaire that included knowledge and practices from pig farmers and non-pig farmers. The questionnaire included questions on demographics, medical history, previous sanitation projects (health policies, strategies, and plans), previous health education and knowledge about TSCT, its transmission, signs/symptoms, treatment, attitude, and practices related to TSCT. The questionnaire was administered in Swahili to a total of 483 respondents and the information was translated into English.

4.4.2 Key informant interviews

The key informants were livestock/veterinary officials, health workers/practitioners, community development, environment and sanitation officials, district and county education officers (primary and secondary schools), head teachers of primary and secondary schools, and local government officials who were to be involved in the study. A total of 38 KIIs were conducted in the four districts with a total of eight villages (two villages per district). To ensure credibility, dependability, and conformability, a pre-tested interview guide was used to interview the KIIs on various aspects of TSCT. The data collected through the KIIs guide and was used to assess perceptions of actual problems related to factors influencing the prevention and control of TSCT. To improve the reliability of interpretation, the written transcripts were independently reviewed by the same two researchers, and a consensus was reached before accepting the data for analysis (Nyangi *et al.*, 2024).

4.4.3 Focus group discussions (FGDs)

Participants in the FGDs (village health committee and primary and secondary school science teachers) were purposively selected (Nyangi *et al.*, 2024). The FGDs were conducted and led by facilitators fluent in Swahili using an FGDs interview guide and a digital recorder to ensure credibility, dependability, and conformability. The recording was done after the FGDs participants gave their consent. Transcription of the recorded data was done by typing in Ms Word for further analysis (Nyangi *et al.*, 2024).

A total of 14 FGDs were conducted using an FGDs interview guide in all four districts, the plan was to conduct 16 FGDs from the eight study villages. We ended with 14 FGDs as two villages had no active village health committee. Out of 14 conducted FGDs, two were of poor quality as the audio could not be heard clearly and failed to be transcribed, so we ended with 12 FGDs (Nyangi *et al.*, 2024). The participants were asked to attend a specially arranged session of 60 to 90 minutes for FGDs. Each FGD comprised a minimum of six and a maximum of 12 participants. To improve interpretation reliability, the written transcripts were reviewed independently by the same

two researchers, and a consensus was reached before accepting them for analysis (Nyangi *et al.*, 2024).

4.4.4 Household observation and infrastructure assessment

Household observation and infrastructure assessment were conducted using a checklist for each household to capture high-risk behaviours/hygiene practices. Direct observations focused on the presence and quality of the toilet in terms of floor, roof, door, pit cover, presence of hand washing facilities with soap (Tippy Taps) in the latrines or outside the latrines, and pig housing systems (confinement, tethering or free-range) and general hygiene of the environment. This was done in the same households where the household survey was conducted.

For the CHEP pilot, pig farmers, non-pig farmers, school teachers, and local leaders, including spiritual leaders and government officials at the community/village level, were asked to form groups and complete a short FGDs interview on the key messages of the CHEP. Their responses formed the basis for the FGDs with 6-12 participants per group. A total of four groups were formed: (i) pig farmers, (ii) non-pig farmers, (iii) government officials including spiritual leaders, and (iv) key informants (primary and secondary school science teachers, livestock extension/veterinary officials). The groups recited on the flipchart what they had discussed in their respective groups; this was then discussed by all participants.

4.4.5 Health Education Intervention

The health education intervention (rapid assessment) for all participants began with a questionnaire intended to identify farmers' knowledge and practices regarding *Taenia solium* life cycle, knowledge of signs of human infection of *Taenia solium*, the transmission of taeniasis and neurocysticercosis, the transmission of porcine cysticercosis, methods of pig keeping, and personal hygiene habits likely to affect the transmission of *Taenia solium* eggs from either pigs or people as well as recognition of tapeworm segments in stool. Farmers were also asked whether the family is always using a latrine for defecation, always washing hands with soap after defecating and before eating, and always washing fruits and vegetables. The administration of the questionnaire was followed by a health education intervention workshop.

The post-intervention was conducted immediately after the health education intervention using the same questionnaire that was used during the pre-intervention survey. The purpose was to conduct a rapid assessment of the effectiveness of the health education interventions using the developed CHEP.

4.5 Analysis of the Data

The data were exported to a Microsoft Excel spreadsheet for cleaning and storage and SPSS version 20.0. (Armonk, NY: IBM Corp) was used for statistical analysis. A chi-square test was used to test for associations between categorical variables. Descriptive statistics were summarised in terms of frequencies and per centages of correct responses. Data from the household observation were also analysed based on the chi-square test using SPSS version 20.0. (Armonk, NY: IBM Corp).

The KIIs and FGDs interviews were recorded with participants' consent using a digital audio device, then transcribed into Swahili and later translated into English for further analysis using thematic analysis and reporting (Nyangi *et al.*, 2024). To improve the reliability of the interpretation, the written transcripts were independently reviewed by the two researchers who were also involved in the transcription and accepted by consensus for analysis. Analysis of the transcripts of the KIIs and FGDs was conducted using ATLAS.ti 8 for windows using inductive thematic analysis (Nyangi *et al.*, 2024).

4.6 Theories used in the Development of the Health Education Package

To transform the assessed risk factors into effective health education messages that would promote behaviour change in the community. The study used the following health behaviour theories to guide the process. The models were intended to provide a framework for interpreting the risk factors that make up the health education package.

4.6.1 Integrated behavioural model (IBM)

The Integrated Behaviour Model is recommended because it incorporates constructs from the Theory of Reasoned Action (TRA), the Theory of Planned Behaviour (TPB), the Health Behaviour Model (HBM), and the Rational Theory (KAP), as well as other influential theories. The Theory of Reasoned Action (TRA) and the Theory of Planned Behaviour (TPB) focus on theoretical constructs that deal with individual motivational factors as determinants of the likelihood of performing a particular behaviour (Montaño and Kasprzyk, 2008). Rational (KAP) and TPB theories have shown that the best predictor of behaviour is behavioural intention, which in turn is determined by attitudes towards the behaviour and social normative perceptions regarding it. TPB is an extension of TRA and includes an additional construct: perceived control over the performance of the behaviour (Champion and Skinner, 2008; Montaño and Kasprzyk, 2008; WHO, 2012). The most important element of behaviour in the IBM is the intention to change the behaviour, because without motivation a person is unlikely to perform a recommended behaviour (Montaño and Kasprzyk, 2008; WHO, 2012).

The Integrated Behavioural Model (IBM) lacks the principles of participation and targeting predisposing factors. The limitation is that this theory is only useful when considering individual health behaviour, without taking into account other determinants of a person's health behaviour and health statuses, such as race, socioeconomic status, or education. To complement this, we had to consult another model known as the PRECEDE-PROCEED Model, which is based on its fundamental principle of participation. We also referred to a third model that also form a bases of our study and that is the health belief model (HBM) with its principle that people are more inclined to engage in healthy behavior when they think doing so can reduce a threat that is likely and would have severe consequences if it occurred. Thoughtful combinations of models may result in more strong interventions, as the models complement each other in describing the studied phenomenon (Champion and Skinner, 2008). However, a potential downside is a practical limit to how many theories can be combined (Champion and Skinner, 2008).

4.6.2 PRECEDE-PROCEED Model

PRECEDE-PROCEED Model relies on its principle of targeting the health education intervention to changeable factors that are most important, and that predispose people to behaviours/practices instead of targeting the behaviours directly (Green and Kreuter, 1992). PRECEDE stands for 'Predisposing, Reinforcing, and Enabling Constructs in Educational/Environmental Diagnosis and Evaluation' while PROCEED stands for Policy, Regulatory, and Organizational Constructs in Educational and Environmental Development (Green and Kreuter, 1992) and was added to the framework to identify the importance of environmental factors that are determinants of health and health behaviour.

4.6.3 Health Belief Model (HBM)

Health Belief Model (HBM) was also used as it comprises several key concepts that foresee why people will take action to prevent, screen for, or control illness conditions. These include susceptibility, seriousness, benefits, barriers to behaviour, clues to action, and self-efficacy (Champion and Skinner, 2008).

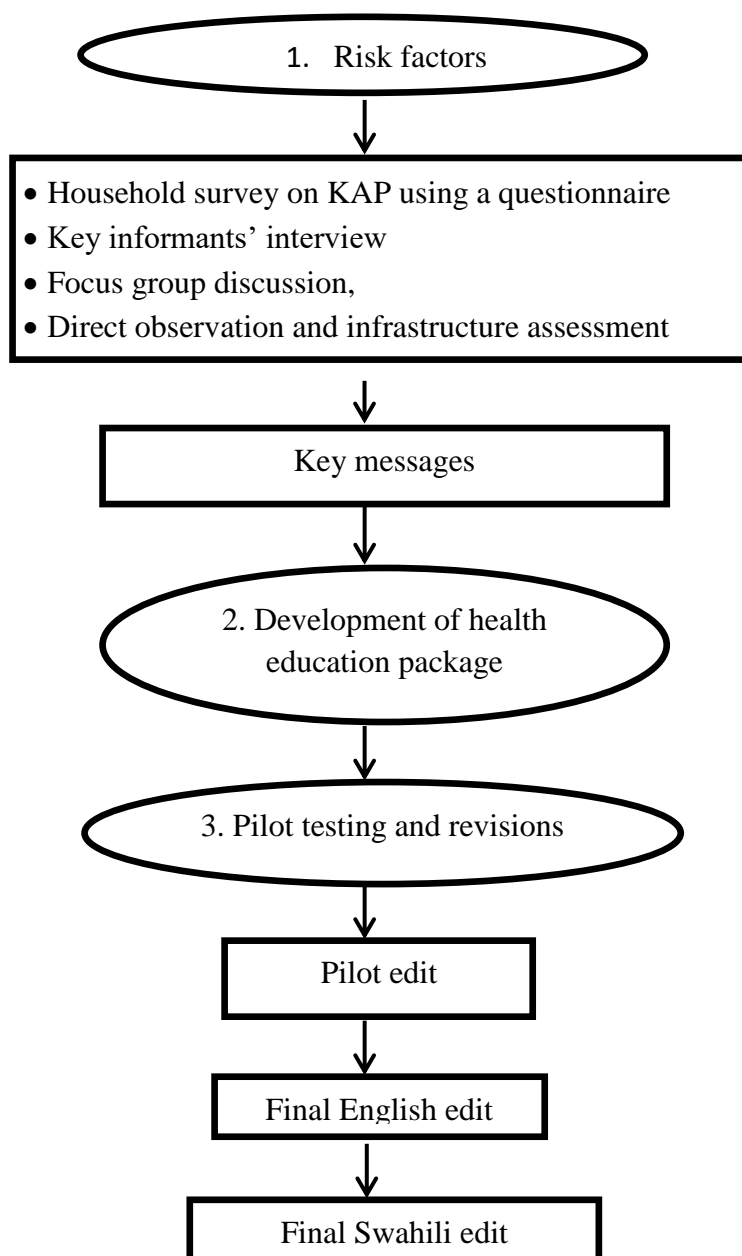


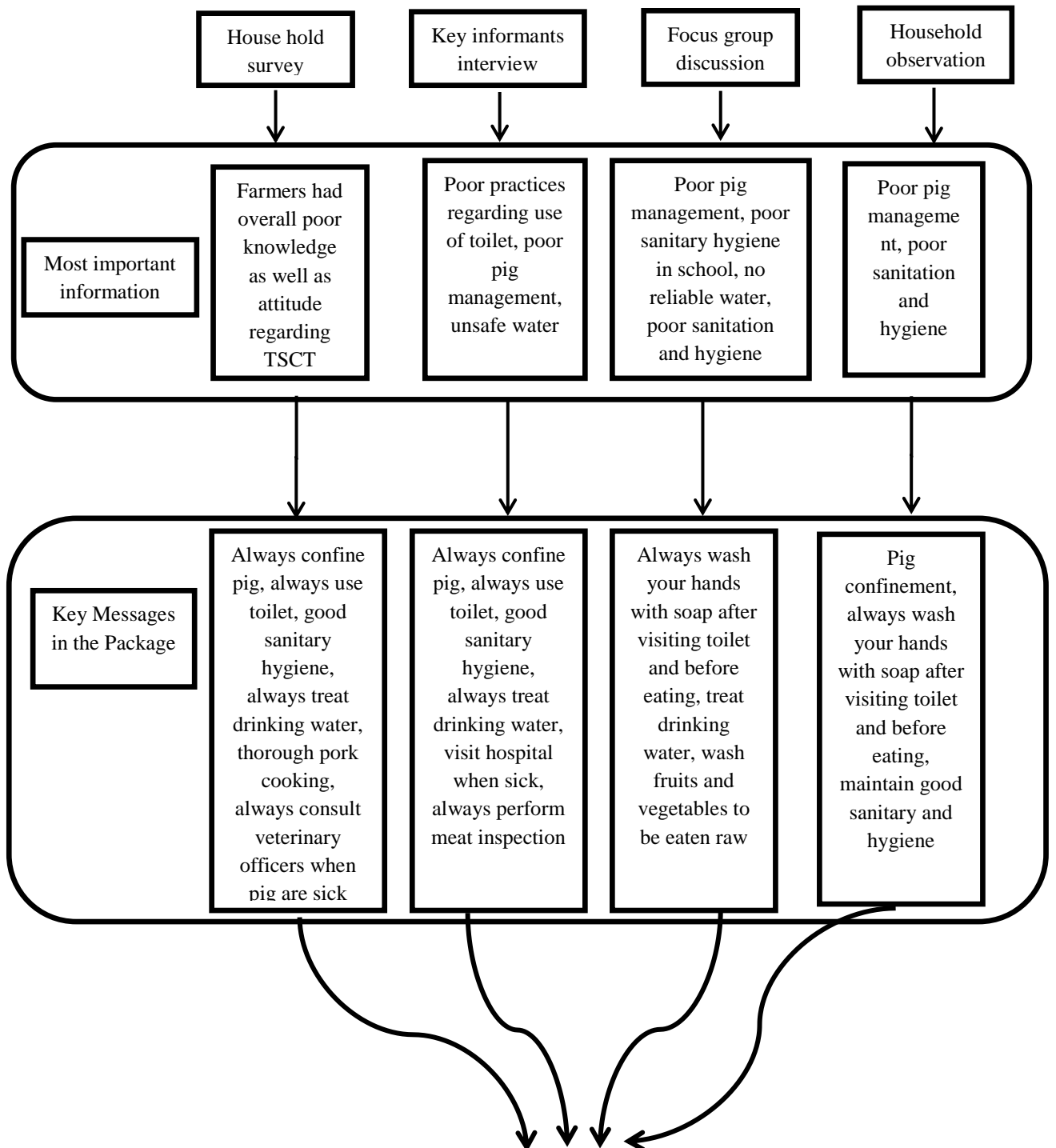
Figure 4.2: Flow diagram showing the steps involved in the development of the CHEP.

4.7 Pilot testing of the Developed Health Education Package

The CHEP was then pilot tested in another village far away from the study villages. Generally, a pilot study precedes and is closely related to a larger study (Eldridge *et al.*, 2016). A pilot project is closely linked to a feasibility study, which serves as the basis for planning a large-scale study (Thabane *et al.*, 2010). Pilot projects are indeed a risk mitigation strategy to reduce the risk of failure of a larger project.

4.8 Results

The results of the formative research informed the development of this health education package and included an assessment of risk factors (Figure 4.3).



The health education package

Figure 4.3: The process of development of CHEP from defining risk factors to the key messages

4.8.1 Key messages

Table 4.1: The formative research and risk factor assessment led to the formulation of the following key messages

Theme	Important information	Key messages
Clean and safe drinking water	Farmers and other community members were not treating drinking water	<ul style="list-style-type: none"> Always boil (treat) drinking water
Pig management	Low knowledge of porcine cysticercosis transmission and control	Always confine your pigs and feed them properly
Proper use of latrines	Some community members were practising open defecation especially on village open market day	Always use latrines and they should be maintained in a good sanitation/ hygiene
Personal hygiene	Farmers and other community members didn't have functional hand-washing facilities in the toilets	Always wash your hands with water and soap after visiting the toilet and before eating
Food safety/hygiene	People in a local bar and open market were practicing improper cooking and poor handling of pork	<ul style="list-style-type: none"> Proper cooking of pork (cooking then frying)
Food safety/hygiene	Washing fruits and vegetable that has to be eaten raw is very important.	<ul style="list-style-type: none"> Always wash fruit and vegetables before eating them raw
Medical services	Most epileptic patients are seeking traditional treatment before visiting hospitals or churches, while most children are visiting hospitals when parents observe worms in their faeces	<ul style="list-style-type: none"> Visit the hospital when you feel sick
Food safety/hygiene	The practice of backyard slaughtering and unreliable meat	<ul style="list-style-type: none"> Always slaughter pigs in a

	inspection	slaughterhouse/slab and perform meat inspection
Extension services	People were self-treating their pigs while others were using traditional medicines	<ul style="list-style-type: none"> Always consult the veterinary officer when your pigs are sick

4.8.2 Results of the pilot test of the education package.

Results from the FGDs showed that participants understood the key messages, with most questions on transmission and the causes of PCC and tapeworm answered correctly. Feedback on the key messages was generally positive, with the majority of participants having a major problem with the question of whether they had ever heard of tapeworm. This question was ambiguous because the Swahili term used was confusing to them, since the word is used in the Swahili language for both tapeworm and cyst. Therefore, with the help of the district and ward livestock officers, the research team revised the message and made it clear and understandable.

4.8.3 Composition of the community-based health education package and proposed main implementation steps

The ready-to-use community-based health education package (CHEP) developed by the community to control TSCT consists training manual for TOTs (Appendix 2.1). The second component consists of a practical guide/booklet with illustrations (pictures) of critical TSCT control strategies, which was also distributed to all TOT participants, communities, and primary and secondary school teachers (Appendix 2.2). The booklet is useful for all community members as it is easy to understand through the use of pictures and a few captions in Swahili. The third component is a brochure (Appendix 2.3) with important information on TSCT control, which was distributed to community members and students. The fourth component of CHEP is a poster (Appendix 2.4) showing the life cycle of the tapeworm (*Taenia solium*) and control points along the cycle.

4.8.4 Rapid assessment of the CHEP

For the rapid assessment, the pre-intervention survey was completed by 57 (45.7%) pig farmers, 16 (19.8%) TOTs, and 28 (34.6%) non-pig farmers. The post-intervention survey was completed by 45 (53.6%) pig farmers, 7 (8.3%) TOTs, and 30 (35.7%) non-pig farmers. Among the participants, 39 (23.6%) were female, and 126 (76.4%) were male. The majority 114 (69.1%) had primary school education and the majority 50 (35%) were between the age of 41 -50 years of age.

Generally, there was an improvement in the knowledge and practices about tapeworm/taeniasis and cysticercosis, though most of the improvements were not statistically significant. Knowledge regarding tapeworm treatment

increased from 61 (81.3%) pre-intervention to 76 (95.0%) post-intervention ($P = 0.008$), while the knowledge regarding condemnation of infected pork increases from 65 (83.3%) pre-intervention to 73 (90.1%) post-intervention ($P = 0.445$). Practices about washing vegetables and fruits statistically significantly improved ($P = 0.025$), while, that of pigs confinement increased from 45 (77.6%) pre-intervention to 54 (88.5%) post-intervention, though, the improvement was not statistically significant (Table 4.2).

Table 4.2: Comparison of knowledge and practices before and immediately after the health education intervention

Question	Correct response n(%)		P-value (χ^2)
	Pre-intervention	Post-intervention	
Knowledge-related questions			
Heard of human tapeworm	62 (77.5)	78 (95.1)	0.001
Tapeworm prevention	76 (96.2)	78 (96.3)	0.975
Tapeworm treatment	61 (81.3)	76 (95.0)	0.008
Heard of human cysticercosis	50 (62.5)	73 (89)	<0.001
Health effect of human cysticercosis	69 (93.2)	80 (98.8)	0.065
Heard of porcine cysticercosis	61 (79.2)	78 (64)	0.006
Prevention of porcine cysticercosis	76 (97.4)	78 (97.5)	0.980
A link between porcine cysticercosis and epilepsy	48 (64.9)	73 (92.4)	<0.001
At risk of getting tapeworm	40 (51.3)	48 (59.3)	0.057
At risk of getting human cysticercosis	44 (57.1)	48 (59.3)	0.328
Safe to eat infected pork	69 (88.5)	76 (93.5)	0.392
Condemnation of infected pork	65 (83.3)	73 (90.1)	0.445
Practice-related questions			
Confining pigs	45 (77.6)	54 (88.5)	0.109
The problem of roaming pigs	68 (89.5)	75 (94.9)	0.203
Wash vegetables and fruits	70 (99.3)	79 (100)	0.025
Using toilet	72 (94.7)	78 (98.7)	0.114
Wash hands after visiting the toilet	69 (92.0)	76 (95.0)	0.433
Wash hands before eating	68 (91.9)	76 (95)	0.433

All p-values are based on a Chi-square analysis of numbers across the four districts

Generally, there was an improvement in tapeworm/taeniasis and cysticercosis knowledge in all three groups. When the results were separately analysed for the pig farmers, non-pig farmers and the TOTs group showed that during the pre-intervention survey, non-pig farmers had greater knowledge about tapeworm transmission ($P < 0.001$), tapeworm treatment ($P = 0.394$) and tapeworm health effect ($P = 0.394$). Pig farmers were more

aware of how tapeworm can be prevented, and the health effects of porcine cysticercosis. The link between porcine cysticercosis and epilepsy was most likely to be understood by pig farmers who were more likely to condemn infected pork. The post-intervention survey showed a large improvement in the knowledge of most aspects of tapeworm/taeniasis and cysticercosis compared with baseline knowledge. The knowledge about tapeworm transmission increased from 41.7% pre-intervention to 63.6% post-intervention for pig farmers and decrease from 92.6% to 86.8% for non-pig farmers. A similar improvement trend was observed for the rest of the analysed variables in all three groups (Table 4.3).

Table 4.3: Comparison of knowledge of the three groups studied

Variables	Correct response n (%)			P-value (χ^2)
	Pig-farmers	TOT's	Non-pig farmers	
1. Tapeworm transmission				
Pre-intervention	15 (41.7)	11 (68.8)	25 (92.6)	<0.001
Post-intervention	28 (63.6)	6 (85.7)	25 (86.8)	0.076
2. Tapeworm prevention				
Pre-intervention	34 (97.1)	16 (100)	26 (92.9)	0.455
Post-intervention	42 (93.3)	7 (100)	29 (100)	0.288
3. Tapeworm treatment				
Pre-intervention	24 (75.0)	13 (81.3)	24 (88.9)	0.394
Post-intervention	41 (93.2)	7 (100)	28 (99.6)	0.663
4. Tapeworm health effects				
Pre-intervention	29 (82.9)	15 (93.8)	27 (96.4)	0.176
Post-intervention	43 (97.7)	7 (100)	29 (100)	0.661
5. Health effect of human cysticercosis				
Pre-intervention	31 (93.9)	14 (93.3)	24 (92.3)	0.970
Post-intervention	44 (97.8)	7 (100)	29 (100)	0.667
6. Prevention of porcine cysticercosis				
Pre-intervention	37 (100)	14 (100)	25 (92.6)	0.144
Post-intervention	42 (95.5)	7 (100)	28 (100)	0.642
7. A link between porcine cysticercosis and epilepsy				
Pre-intervention	21 (63.6)	9 (60.0)	18 (69.2)	0.821
Post-intervention	42 (95.5)	7 (100)	24 (100)	0.229
8. At the risk of getting tapeworm				
Pre-intervention	18 (51.4)	7 (43.8)	15 (55.6)	0.282
Post-intervention	32 (71.1)	4 (57.1)	12 (41.4)	0.051
9. At the risk of getting human cysticercosis				
Pre-intervention	18 (52.9)	8 (50.8)	18 (66.7)	0.351
Post-intervention	32 (71.1)	4 (57.1)	12 (41.4)	0.103
10. Safe to eat infected pork				
Pre-intervention	31 (88.6)	13 (81.3)	25 (92.6)	0.788
Post-intervention	42 (93.3)	7 (100)	27 (93.1)	0.898

*TOT: Training of trainers (government official who will train the large community)

All p-values are based on a Chi-square analysis of numbers across the four districts Regarding practices, pig farmers were more aware of the effect of free-roaming pigs while, non-pig farmers were more aware of the practices related to washing of fruits and vegetables before consumption, using toilets, and washing hands before eating and after visiting toilet (Table 4.4).

Table 4.4: Comparison of practices of pig farmers, non-pig farmers and TOT's

Variables	Correct response n(%)			P-value (χ^2)
	Pig-farmers	TOTs*	Non-pig farmers	
1. Do you completely confine your pigs				
Pre-intervention	7 (20)	3 (27.3)	3 (25)	0.855
Post-intervention	3 (6.8)	3 (60.0)	1 (8.3)	0.019
2. Do you think it is harmful if pigs roam free?				
Pre-intervention	32 (91.4)	14 (93.3)	22 (84.6)	0.607
Post-intervention	41 (93.2)	7 (100)	27 (96.4)	0.569
3. Do you always wash vegetables and fruits				
Pre-intervention	32 (94.1)	13 (86.7)	25 (96.2)	0.478
Post-intervention	43 (100)	7 (100)	29 (100)	**
4. Do you always use the toilet				
Pre-intervention	33 (94.3)	13 (86.7)	26 (100)	0.203
Post-intervention	42 (97.7)	7 (100)	29 (100)	0.541
5. Do you always wash your hands after visiting the toilet				
Pre-intervention	31 (91.2)	13 (92.9)	25 (92.6)	0.801
Post-intervention	42 (95.5)	7 (100)	27 (93.1)	0.627
6. Do you always washing hands before eating				
Pre-intervention	31 (91.2)	12 (92.3)	25 (92.6)	0.978
Post-intervention	42 (95.5)	7 (100)	27 (93.1)	0.627

All p-values are based on a Chi-square analysis of numbers across the four districts

*TOT: Training of trainers (government officials who will train the large community)

**No statistics are computed because the variable is a constant.

4.9 Discussion

This community-based health education package on TSCT control was developed with community participation to bring about behaviour change and promote community ownership of the programme. The rapid assessment of the package resulted in improvement in knowledge and practices in all three groups assessed (pig farmers, TOTs, and non-pig farmers) (Table 4.2-4.4). This conventional approach is more suitable for most endemic areas where other approaches such as video and digital technology are not feasible due to poor infrastructures such as lack of electricity, internet, and computers/laptops/tablets/smartphones.

The following health behaviour models were used to translate the measured risk factors into actionable educational messages to encourage the population to change their behaviour.

The Health Belief Model (HBM) includes several key concepts that predict why people will take action to prevent, screen for, or control health conditions (Champion and Skinner, 2008). These include susceptibility, seriousness, benefits, barriers to a behaviour, incentives to act, and, self-efficacy; all of which are strong predictors of preventive health behaviours (Champion and Skinner, 2008). Our results do not support this model as most respondents/participants were not aware that they were at risk of contracting TSCT (perceived susceptibility); the majority were also unaware of the severity of the disease and its consequences (perceived severity) as most were unaware of the health effects of taeniasis on humans as well as cysticercosis to both pigs and humans. On the other hand, the study supports the model as most of the participants believed in the effectiveness of the recommended risk reduction measures (perceived benefits). However, most of them thought about the tangible costs of the measure (perceived barriers), such as the cost of building pig pens, access to pig feed, and the cost of building modern toilets. People had low self-efficacy in controlling TSCT, as the majority felt that some of the actions that need to be taken to control TSCT are difficult to achieve (self-efficacy). The education package developed was intended to influence the population's perceived susceptibility to TSCT to improve their behaviour to prevent infection.

Therefore, the lack of knowledge combined with the poor hygiene and sanitation in the study area would likely lead to infection with TSCT (Nyangi *et al.*, 2022).

This led to the inclusion of the following messages in the package alongside the key points on TSCT prevention:

- 1) Raise awareness of TSCT among the study population. The messages included were the risk of infection" (perceived vulnerability) (Champion and Skinner, 2008).
- 2) Conviction of participants/respondents that it is within their choice to change their behaviour and reduce the risk of infection (self-efficacy) (Champion and Skinner, 2008). This implies that they can protect themselves from TSCT through improved hygiene practices.

In terms of the integrated behavioural model (IBM), the results of this study support the model as most respondents showed the intention to carry out the behaviour, especially after they became aware of the consequences of TSCT for themselves and pigs. Individuals' habituation to scientific knowledge alone

does not necessarily lead to behaviour change. Rather, behaviour is related to perceptions, values, power relations, and feelings and cannot be changed simply by acquiring knowledge (Gazzinelli *et al.*, 2012). There is extrinsic motivation, when a person engages in an activity to achieve or avoid a particular outcome, many of the things you do every day are likely extrinsically motivated. Intrinsic motivation is where there is an internal drive for success or meaningfulness. Finally, the family is motivated by a desire to care for those they love (Rodgers and Loitz, 2008). The person will perform a recommended behaviour (Rodgers and Loitz, 2008). The package will be shared with key stakeholders and policymakers who were involved from the beginning; these included politicians, ministries of health and education, and the key informants mentioned in this paper. These are the key people to enforce the existing laws if people are not willing to change their practices and behaviour.

Based on the **PRECEDE-PROCEED** model, the main purpose of this model is to provide a framework for planning and evaluating health behaviour change programmes. This model was relevant to the design of this study because its methodology addresses the problem that health education focuses too much on programme delivery and too little on programme design. This is deliberately planned to meet evidenced needs (Bartholomew *et al.*, 2006). The underlying principle of this model is participation, which states that success in achieving change is enhanced by the active involvement of the proposed target group in describing their priority problems and goals and in developing and implementing solutions (Green and Kreuter, 1992). In developing the package, much emphasis was placed on developing a community-based health education package that meets the needs of the target community. Interventions that involve the community can promote behaviour change and community ownership of programmes (Gazzinelli *et al.*, 2012). The CHEP is expected to be accepted by the community, as evidenced by the KAP baseline survey experience. The community indicated that lack of education is the key factor for TSCT infection and they wanted more health education to be done to improve KAP and raise awareness to control TSCT.

The rapid assessment of the developed CHEP was conducted in Babati district. Generally, there was an improvement in the knowledge and practices of tapeworm/taeniasis and cysticercosis. Knowledge regarding tapeworm treatment increased from 61 (81.3%) pre-intervention to 76 (95.0%) post-intervention ($P = 0.008$), while the knowledge regarding condemnation of infected pork increases from 65 (83.3%) pre-intervention to 73 (90.1%) post-intervention ($P = 0.445$). These results are comparable to those report from other health education intervention conducted in Tanzania and reported an improvement in knowledge regarding taeniasis, porcine cysticercosis, human cysticercosis (Ngowi *et al.*, 2011; Ertel *et al.*, 2015; Mwidunda *et al.*, 2015).

The results are also comparable to other studies conducted elsewhere in endemic countries (Sarti *et al.*, 1997; Wohlgemut *et al.*, 2010; Alexander *et al.*, 2012; Hobbs *et al.*, 2018; Beam *et al.*, 2019; Vaernewyck *et al.*, 2020).

Practices about washing vegetables and fruits statistically significantly improved ($P = 0.025$), while, that of pigs' confinement increased from 45 (77.6%) pre-intervention to 54 (88.5%) post-intervention. The results are comparable to those conducted in Kenya and reported a significant increase in tethering practices (Wohlgemut *et al.*, 2010), and a study from Mexico that reported a significant reduction in free – range pigs by 50% (Sarti *et al.*, 1997).

4.10 Conclusion

This paper describes the development and rapid assessment of the community-based health education package (CHEP) for TSCT control in Tanzania. Which comprises four components including; a training manual for the training of trainers (TOTs), a booklet with illustrations and instructions on how to perform small doable actions, brochure, with key messages and poster with a tapeworm life cycle. It is recommended that to achieve the maximum impact of the intervention, the educational package should be combined with other existing control strategies as well as other intervention methods such as video, cartoons for school children, and a computer-based health-education tool (the vicious worm). It is also recommended that the interventions preventing TSCT reinfection, such as improvements in hygiene achieved through health education, are urgently required to augment the effect of other control strategies as part of an integrated approach.

In my opinion, the only way to reach the UN Sustainable Development Goals (SDGs) is through an integrated approach for the control strategies incorporating the diagnostic tests according to the *Taenia solium* life cycle. The need for effective educational tools that can be integrated into existing interventions to combat TSCT infections and other neglected tropical diseases was expressed in a Research Agenda for Helminths Disease (Boatin *et al.*, 2012). Interventions including health education to prevent TSCT and other worm infections are urgently needed to improve the sustainability and effectiveness of other existing control strategies as part of an integrated approach. It is assumed that the CHEP developed can be easily adapted and implemented by communities in resource-poor endemic countries, which in turn will improve community health and well-being.

Ethical considerations

The study was approved by the National Institute of Medical Research (NIMR) with approval number NIMR/HQ/R.8a/Vol. IX/2802. The study also received approval from the ethics committee of the Klinikum rechts der Isar, Technical University of Munich, Germany, under the number 537/18 S-

KK. Each participant was informed about the objectives of the study and verbal consent was obtained from each head of household to be interviewed.

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CHAPTER FIVE

5.0 GENERAL DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

5.1 General discussion, and conclusions

This chapter summarises the major findings of the study, the discussion, the overall conclusions, theoretical implications, and recommendations. The chapter further explains the contribution of the thesis to the body of existing knowledge, and finally outlines the areas suggested for further studies.

The first specific objective of this study was to assess community knowledge, attitude, and practices (KAP) in control of TSCT. The study findings revealed that the knowledge was generally poor regarding transmission, disease clinical signs/symptoms, prevention, and treatment of TSCT among the study populations. This is possible because taeniasis is confused with other intestinal worms that show similar signs/symptoms. Knowledge regarding correct treatment was poor, as none of the respondents could provide a correct name for the medication to treat taeniasis. The knowledge regarding modes of transmission was also poor for similar reasons that respondents were confusing taeniasis with other intestinal worms, which makes most of them mention the transmission mode of other intestinal worms. Knowledge regarding human cysticercosis (HCC) was poor with the majority of the respondents reported not having ever heard of HCC before, including all aspects of transmission, disease clinical signs/symptoms, treatment, or prevention. In general, the knowledge level of porcine cysticercosis (PCC) was moderate across all four districts and was considerably better than the knowledge of HCC. The results indicated that pig keepers have a higher good practice knowledge. This means some education intervention might have already been conducted for pig keepers before the study. Most of the practices reported by the respondents during the questionnaire survey differed from those observed directly during household observations.

Perhaps farmers could not present the reality during the questionnaire survey. They could have felt ashamed or afraid of unveiling the reality in terms of bad practices related to the TSCT infection, and perhaps a fear of being penalized by the government because of non-compliance with health and sanitation by-laws. For example, during questionnaire administration, some farmers said they confined their pigs but during household observation, the pigs were found roaming. In other instances, some farmers claimed that they always used toilets, but during the household visit for observation, they did not have even a toilet around their homestead, and if available, it seemed to have not been used. The strength of applying a multi-methods approach for triangulation is hereby proven especially when sensitive issues are being investigated.

The second specific objective of this study was to assess socio-demographic and cultural factors influencing knowledge and practice regarding TSCT. The findings from this study revealed that respondents' and participants' education levels, sex, and geographic locations (districts) were the main factors that significantly contributed to the overall model that determined knowledge and practices toward TSCT. Respondents with tertiary education were found to be more likely to have heard about tapeworm ($P=0.0072$), to have awareness of *T. solium* transmission ($P=0.0020$), *T. solium* health effects ($P=0.0046$), and human cysticercosis (HCC) transmission ($P=0.0282$). With regards to practices, respondents from Mpwapwa district were more likely to wash their hands with soap after defecation ($P<0.0209$), more likely to know the health effects of *T. solium* ($P=0.0026$), and more likely to be aware of HCC transmission ($P=0.0001$). Male respondents were more likely to know about PCC transmission ($P=0.0006$), and wash their hands with soap before eating ($P=0.0216$) compared to women, this could be due to the reason that men are responsible for pig slaughtering and selling pork. It could also be because women are particularly disadvantaged due to the social and economic priority granted by the wider society to men. The study further revealed that socio-demographic factors influence knowledge and practices concerning TSCT control. Education level was the main factor that significantly contributed to the knowledge and practices of TSCT. It is, therefore, necessary to understand the influence of socio-demographic factors on the efforts to control and eradicate TSCT. However, more consideration should be given to health education to create awareness and change in practices and behaviour towards the control of TSCT.

The third specific objective was to develop and conduct a rapid assessment of a ready-to-use community-based health education package for controlling TSCT in Tanzania. This community-based health education package for control of TSCT was developed collaboratively with the community to promote behavioural change and community ownership of the program. The formative research method was used in the development of the package. To

understand the human and natural environment in study areas, both quantitative and qualitative research methods were applied. Pig farmers, teachers, health workers, education officials, health officials, environmental and sanitation officers, community development workers, and livestock field officers/veterinarians were included in the formative research phase, which included TSCT risk factor and context assessment. The formulated nine key messages then led to the development of the health educational package. Three health behavioural models were used to bring the information across to interpret the measured risk factors into operational educational messages that will encourage the community to change their behaviour. The developed community-driven ready-to-use health education package (CHEP) for control of TSCT is composed of a training manual for the training of trainers (TOTs). The CHEP also includes a leaflet with important information regarding the control of TSCT to be distributed to the community members and students. The third component of CHEP is a poster with the lifecycle of tapeworm to be displayed in schools, local government offices, and public places, and the fourth component is a booklet containing illustrations (images) addressing TSCT critical control strategies to be distributed to the community/students.

The rapid assessment of the developed CHEP was conducted in Babati district. Generally, there was an improvement in the knowledge and practices of tapeworm/taeniasis and cysticercosis. Knowledge regarding tapeworm treatment increased from 61 (81.3%) pre-intervention to 76 (95.0%) post-intervention ($P = 0.008$), while the knowledge regarding condemnation of infected pork increases from 65 (83.3%) pre-intervention to 73 (90.1%) post-intervention ($P = 0.445$). Practices about washing vegetables and fruits significantly improved ($P = 0.025$), while, that of pigs' confinement increased from 45 (77.6%) pre-intervention to 54 (88.5%) post-intervention.

5.2 Recommendations

- It is recommended to scale up the efforts of knowledge sharing with the general population on transmission, TSCT clinical signs/symptoms, control, treatment, and prevention in Tanzania, preferably in a one health approach, to improve favourable KAP for control and eventual elimination of TSCT. Results gained from this study can be applied in designing context-specific health education packages to reach a large community and that may align to some of the goals specified in the NTD roadmap 2030.
- It is recommended that studies that include health education interventions to the population in endemic areas should also consider socio-demographic factors.
- It is recommended that to achieve the maximum impact of the intervention, the educational package should be combined with other existing control strategies as well as other intervention methods such

as video, cartoons for school children, and a computer-based health-education tool such as the vicious worm.

- It is also recommended that the interventions preventing TSCT reinfection, such as improvements in hygiene achieved through health education, are urgently required to augment the effect of other control strategies as part of an integrated approach. In my opinion, the only way to reach the UN Sustainable Development Goals (SDGs) is through an integrated approach for the control strategies incorporating the diagnostic tests according to the *Taenia solium* life cycle

5.3 Study contributions

5.3.1 Contribution to the body of knowledge

5.3.1.1 Development of a community-based health educational package to prevent *Taenia solium* taeniasis/cysticercosis in a population

As one of its contributions, the study developed, and pilot-tested the CHEP for control of TSCT. The study employed a community-based mixed methods approach involving input from the questionnaire survey of the pig-farmers target group, non-pig farmers, interviews with key informants (KIs), Focus group discussion (FGDs), and direct household infrastructure observation. The KIs included the head of the primary, and secondary schools, veterinary officers, health officials, environmental and sanitation officers, community development officers, and educational officers at ward and district levels. FGDs with the village health committee (VHC) and science subjects' teachers from primary and secondary school were also conducted to identify potential TSCT infection risks in the study area using the FGDs guide. Household infrastructure observation was also conducted using an observation checklist for the same households that participated in a questionnaire survey. The collected information led to the formulation of key messages for the development of the CHEP.

The study assessed the risk factors of the natural and human environment such as transmission hot spots, risk behaviour for infection, as well as the feeling/emotional, social, and cultural context of the target population in questionnaires, interviews, FGDs, KIs, and direct household observations. This was achieved by employing a formative research approach and included an assessment of the local context and TSCT infection risk factors (CDC, 2013). The study also assessed the specific needs of the target population, local customs and traditions and taboos, and TSCT infection risk factors, and integrated them into the CHEP guided by behavioural models (Chapter 4). The outcomes of the risk factor assessment were then translated into key messages for the development of the CHEP. Therefore, the experiences gained in this thesis contribute significantly to the evidence base in the field of health educational development (Chapter 4).

5.3.1.2 Contribution to the body of knowledge with the theories that guided the study

The health belief model (HBM) contains several key concepts that forecast why people will take action to prevent, screen for, or control health conditions. These include susceptibility, seriousness, benefits, barriers to behaviour, cues to action, and most recently, self-efficacy; all of them are strong predictors for preventive health behaviour. The results from the present study support the model as most of the participants believed in the efficacy of the advised action to reduce risk (perceived benefits) though, most of them think of the tangible cost of taking the action (perceived barriers), such as the cost of constructing pig pen and accessing pig feed as well as the cost of constructing modern toilets. People had low self-efficacy towards the control of TSCT as the majority think that some of the actions to be taken towards control of TSCT are difficult to achieve (self-efficacy).

A second model used in this study was a PRECEDE-PROCEED model. This model was significant when designing this study, as its method addresses the concern that health education emphasises too much on program implementation, with little emphasis on program-designing interventions that are deliberately planned to meet proven needs (Bartholomew *et al.*, 2006). For this purpose, the study adopted part of the model during the development of the CHEP, mostly phase 1 to phase 4. The fundamental principle in this model is participation, which states that success in attaining change is improved by the vigorous participation of the intended audience in describing their high-priority problems and goals and in developing and implementing solutions (Gielen *et al.*, 2008). Since the gap in the community was identified, it was necessary to employ a planning model like PRECEDE-PROCEED, which has been a basis of health promotion practice for decades, and that can help guide this process and fix the problem (Gielen *et al.*, 2008).

Another model upon which this study was built, was the integrated behaviour model (IBM) and this is recommended as it includes constructs from the Theory of Reasoned Action (TRA); Theory of Planned Behaviour (TPB); Health Behaviour model (HBM), and rational (KAP) theory as well as from other influential theories). The most significant determining factor of behaviour in IBM as it is in TRA and TPB is the intention to perform the behaviour (Montaño and Kasprzyk, 2008). Without motivation, a person is unlikely to carry out a recommended behaviour. This model is lacking the principles of participation and of targeting predisposing factors which indicate that not only the motivation will make a person perform an action but also the power that an individual possesses, for example, in terms of knowledge. That power can be enhanced through the active engagement of that person in a given phenomenon for enhancing power. And here the reference is the

health education package that engages the community in its design and implementation. The results from this study support the model as most of the respondents/participants showed intention to perform the behaviour especially after they became aware of the consequences of TSCT to themselves and pigs. With motivation, it is most likely for the person to carry out a recommended behaviour.

5.4 Suggested Areas for Further Research

5.4.1 Further evaluation of the educational package

Follow-up studies could provide information on several additional outcomes measuring the impact of the health educational package. These include measures of cost-effectiveness, such as for example, establishing how much the educational intervention costs per person and per infection prevented. This can be measured both including and excluding the development and production costs of the CHEP.

Future trials may also aim to investigate the impact of the educational package on communities, in combination with improved water and sanitation hygiene (WASH). Moreover, observed hygiene practice could be more extensively assessed in addition to hand washing, e.g. around household food preparation. From the educational perspective, other knowledge gaps include the impact of the intervention on the mental development of the children. In addition to our quantitative KAP measurements, follow-up studies could also qualitatively assess and evaluate the effect of knowledge increase on practice, infection rate, and morbidity. Other knowledge gaps include the impact of purely community-based interventions on schools (primary and secondary school) and comparing the effectiveness of community-based versus school-based interventions.

5.4.2 Research needs for scaling-up

For a potential scaling-up of the control package developed within this thesis, follow-up studies are required to establish to what extent the educational package is culturally adaptable and effective in other TSCT-endemic areas. Future research should also investigate the feasibility of converting the conventional package into video/cartoon-based intervention for school children and the wider community. The effectiveness of these different intervention strategies and media also needs to be established scientifically. Additionally, the adaptability of the approach to other diseases/conditions of public health relevance where control efforts include behaviour change can be investigated.

5.4.3 Research needs for sustainable control of TSCT

To establish the impact of the educational package under different conditions and in different environments, several tools are urgently required. For example, the development of new (field compatible) diagnostics for TSCT,

allows a more accurate evaluation of the intervention impact. More accurate diagnostic tools for surveillance become increasingly important with decreasing infection intensities and prevalence and should therefore be a top research priority.

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APPENDICES

Appendix 1: QUESTIONNAIRE, FOCUS GROUP DISCUSSIONS (FGDs), HOUSEHOLDS OBSERVATION AND KEY INFORMANTS INTERVIEW GUIDE FORMS

1A: A questionnaire to explore pig and non-pig farmers' Knowledge, Attitude, and Practices (KAP) related to *Taenia solium* taeniasis/cysticercosis infection, transmission, prevention/control, and treatment⁵

To be filled in by the research team:

Date _____ Interview _____

District _____ Ward _____ Village _____

Personal Information: this part should be filled by the enumerator by interviewing the respondents

Name _____

Phone number _____

Age (years) _____

Sex: (1) Male

(2) Female

Background of respondent

1. How long have you been living in this village? (years)
 - (1) < 1
 - (2) 1-5
 - (3) 6-10
 - (4) >10
 - (5) All my life
2. How long have your family been living in this village? (years)
 - (1) < 1
 - (2) 1-5
 - (3) 6-10
 - (4) > 10
 - (5) All my life
3. What is the most challenging problem in your village?
.....
What's the most serious health concern in your village (Please rank 5 out of these 8)
 - (1) Diarrhoea
 - (2) Malnutrition
 - (3) Abdominal pain
 - (4) Cardio-vascular diseases
 - (5) Intestinal worm
 - (6) Malaria
 - (7) Flu
 - (8) Cholera
 - (9) Other diseases (mention)

Socio-Economic Status

4. Level of Education
 - (1) No formal education
 - (2) Primary school education
 - (3) Secondary school education
 - (4) Tertiary education
5. Occupation
 - (1) Farmer
 - (2) Livestock keeping
 - (3) Business
 - (4) Fishing

- (2) Others (mention).....
6. Position of the respondent in the household
- (1) Father
 - (2) Mother
 - (3) Children
 - (4) Others
- (mention).....
7. How many people (including yourself) are there in your household?
- (1) Alone
 - (2) 2-3
 - (3) 4-5
 - (4) 6-7
 - (5) > 7
8. How many people (including yourself) in your family earn an income?
9. Where do most of your family incomes come from? (Choose one answer)
- (1) Farming
 - (2) Livestock keeping
 - (3) Business
 - (4) Fishing
 - (5) Farming and livestock keeping
 - (6) Farming and business
 - (7) Farming, business, and livestock keeping
 - (8) Other sources (mention)
10. Are you a member of the savings and credits cooperative society (SACCOS)?
- (1) Yes
 - (2) No
11. Can you save some of your earnings?
- (1) Yes
 - (2) No
- 12a. If no, give reasons
12. What do you or your family members own out of the provided list below (more than one answer is possible)
- (1) Tap water
 - (2) Modern toilet
 - (3) Radio
 - (4) Television set
 - (5) Satellite dish
 - (6) Smartphone
 - (7) Bicycle
 - (8) Motorcycle
 - (9) Other assets (mention)

13. Do you have any land for your farming?
 (1) Yes
 (2) No
14. Do people in your household including yourself own any animals?
 (1) Yes
 (2) No
- 15a If yes, how many:
 Chicken? _____ Cows? _____ Ducks? _____ Goats?

 Pig _____ Donkey? _____ Sheep? _____ Others? -

Knowledge/Transmission, Symptoms & Treatment

Please write down what you have heard and what you know about worms that makes human and pigs sick. You may also write tick: "I don't know."

15. Have you heard about intestinal worms (*Taenia solium*)?
 (1) Yes
 (2) No
 (3) Don't know
- 16a. If yes, what was the source of information regarding *Taenia solium*?
 (1) Friends
 (2) Poster
 (3) Radio
 (4) Health centers
 (5) School
 (6) Parents/family
 (7) Never heard/seen
 (8) Others sources (mention)
17. How do you think intestinal tapeworm (*Taenia solium*) infection is acquired?
 (1) By eating undercooked or raw pork containing cyst
 (2) By drinking water contaminated with tapeworm eggs
 (3) Don't know
 (4) Others (mention).....
18. Do you think intestinal worms (*Taenia solium*) can cause health problems in a human?
 (1) Yes
 (2) No
 (3) Don't know
19. What are the symptoms of people infected with intestinal worm (*Taenia solium*) (more than one answer is possible)
 (1) Presence of skin nodules
 (2) Blindness
 (3) Weight loss, weakness

- (4) Diarrhoea
 - (5) Enlargement of the stomach
 - (6) Slow growth
 - (7) Poor appetite
 - (8) Abdominal discomfort
 - (9) Worms expel in stool
 - (10) Other symptoms (mention):
 - (11) Don't know
20. Is there a way to prevent human beings from getting tapeworm?
- (1) Yes
 - (2) No
 - (3) I don't know
- 20a If yes (mention).....
21. Can intestinal worm (*Taenia solium*) be treated?
- (1) Yes
 - (2) No
 - (3) Don't know
- 21a. If yes, what medicine do you use for the treatment of *Taenia solium*? (more than 1 answer is possible)
- (1) Mebendazole
 - (2) Albendazole
 - (4) Niclosamide
 - (5) Praziquantel
 - (6) Don't know
 - (7) Other medications (mention).....
22. What is the name of a cyst in your local language?
- (1) Fini
 - (2) Funza
 - (3) Keni
 - (4) Cyst
 - (5) Chenga
 - (6) Mtama
 - (7) Other names (mention).....
23. Have you heard of human cysticercosis?
- (1) Yes
 - (2) No
 - (3) Don't know
- 23a. If yes, what were the sources of information? (more than one answer is possible)
- (1) Friend
 - (2) Poster
 - (3) Radio
 - (4) Health centers
 - (5) School
 - (6) Parents/family

- (7) Seen myself
 - (9) Other sources (mention)
24. How can a human being acquire cysticercosis? (more than one answer is possible)
- (1) Unwashed vegetables/fruits to be eaten raw
 - (2) Eating food/drinking water contaminated with tapeworm eggs
 - (3) Not washing hands after visiting the toilet and before eating
 - (4) Eating improper cooked or raw pork infected with cyst
 - (5) Others (mention).....
 - (6) Don't know
25. What are the possible cyst locations in the human body? (more than one possible is answers)
- (1) Muscles
 - (2) Under the skin
 - (3) Brain
 - (4) Eyes
 - (5) Stomach
 - (6) Other locations (mention)
 - (7) Don't know
26. Do you think cysticercosis can cause serious health effects on a human?
- (1) Yes
 - (2) No
 - (3) Don't know
- 26a. If yes, mention
27. Is there any way to prevent someone from getting human cysticercosis?
- (1) Yes
 - (2) No
- 27a. If yes, mention.....
28. Have you heard about porcine cysticercosis?
- (1) Yes
 - (2) No
- 28a. If yes, what were the sources of information?
- (1) Friend
 - (2) Leaflets
 - (3) Radio
 - (4) Slaughterhouse
 - (5) Parents/family
 - (6) Seen myself
 - (7) Other sources (mention)
29. How can a pig acquire cysticercosis?
- (1) Feeding on feed/water contaminated with tapeworm eggs
 - (2) Feeding on human faeces contaminated with tapeworm eggs
 - (3) Others (mention)

- (4) Don't know
30. What are possible cyst locations in pigs? (more than one answer is possible)
- (1) Muscles
 - (2) Under tongue
 - (3) Brain
 - (4) Heart
 - (5) Stomach
 - (6) Other location (mention)
31. What measures do you take when you find out that your pigs are infected with a cyst?
- (1) Consult veterinary doctor/livestock field officers
 - (2) Treatment with traditional medicine
 - (3) Take no measures
 - (4) Others (mention)
- 31a. If traditional medicine, mention
32. Do you think cysticercosis can cause serious health effects to pigs?
- (1) Yes
 - (2) No
 - (3) Don't know
- 32a. If yes, mention
33. Is there a way to prevent pigs from porcine cysticercosis?
- (1) Yes
 - (2) No
 - (3) Don't know
- 33a. If yes, list.....
34. Have you heard of human epilepsy?
- (1) Yes
 - (2) No
 - (3) Don't know
- 34a. If you have heard about human epilepsy, what are the sources of information?
- (1) Friend
 - (2) Television set
 - (3) Radio
 - (5) Health centers
 - (6) Parents/family
 - (7) Seen myself
 - (8) Others sources (mention)
 - (9) Don't know
35. How does human being acquire epilepsy?
- (1) Eating food/water contaminated with tapeworm eggs
 - (2) Eating unwashed raw vegetables/fruits
 - (3) Eating undercooked or raw pork infected with cyst
 - (4) Inherit from parents

- (5) Bewitched
 - (6) Others (mention).....
 - (7) Don't know
36. Have you ever heard or seen an epileptic patient in your village?
- (1) Yes
 - (2) No
- 36a. If yes how many epileptic patients have you seen
37. What are the signs/symptoms of a person suffering from epilepsy?
(more than one answer is possible)
- (1) Feeling tired
 - (2) Blindness
 - (3) Seizure
 - (4) Frothing in mouth
 - (5) Severe headache
 - (6) Other symptoms (mention):
 - (7) Don't know
38. What are the preventive measures against human epilepsy? (more than one answer is possible)
- (1) Personal hygiene/environmental sanitation
 - (2) Proper cooking of pork
 - (3) Proper use of sanitary toilet
 - (4) Washing of fruits/vegetables to be eaten raw
 - (5) Drink clean and safe water
 - (6) Seek treatment when sick
 - (7) Participate in prayer/worship
 - (8) I don't know
 - (9) Others (mention)
39. Have you or your family member ever suffered from epilepsy?
- (1) Yes
 - (2) No
40. If you or your family members had epilepsy, did you get treatment?
- (1) Yes
 - (2) No
- 40a. If yes, where did you go for treatment?
- (1) Hospital (doctor)
 - (2) Used traditional medicine
 - (3) Other treatment (mention)
 - (4) Never go for treatment
- If receive other treatments, give reasons
- If went for traditional treatment, give reasons
- If went for treatment in hospital, give reasons
- If never receive treatment, give reasons

41. What are the impacts of epilepsy on patient education (more than one answer is possible)
- (1) School dropout
 - (2) Refusal admission
 - (3) Abscond from school
 - (4) Poor academic performance
 - (5) Other impacts (mention)
 - (6) Don't know
42. Does the epileptic patient become a burden to the family?
- (1) Yes
 - (2) No
 - (3) Don't know
- 42a If yes, what were the reasons?
- (1) Medical expenses
 - (2) Lower the family income
 - (3) Other reasons (mention)
-
43. Are there any marital problems caused by epilepsy?
- (1) Marital disputes
 - (2) Separation
 - (3) Divorce
 - (4) No problem
 - (5) Other problems (mention)
44. Does epileptic patient participate in various socio gatherings and activities?
- (1) Yes
 - (2) No
- 44a. If yes, what are the socio activities participated by epileptic patients?
- (1) Wedding ceremony
 - (2) Worshipping/prayer
 - (3) Burial ceremony
 - (4) Savings and credits cooperatives
 - (5) Other socio activities (mention)
45. Does epilepsy caused any difficulties in getting married?
- (1) Yes
 - (2) No
- 45a. If yes, who faced those difficulties?
- (1) Myself
 - (2) Other family members
 - (3) Family member with epilepsy
46. Can epilepsy be transmitted from a patient to a non-patient?
- (1) Yes
 - (2) No
 - (3) Don't know
- 46a. If epilepsy can be transmitted, what are the transmission

- channels?
- (1) Handshaking
- (2) Eating with an epileptic patient
- (3) Sleeping with an epileptic patient
- (4) Sex with an epileptic patient
- (5) Other channels (mention)

Attitude

In the next few questions please tell us how you feel about *Taenia solium*.

- 47. Do you think you are at risk of *Taenia solium* infection?
 - (1) Yes
 - (2) No
 - 47a. If yes, give reasons
 - 47b. If no, give reasons
- 48. Do you think you are at risk of cysticercosis infection?
 - (1) Yes
 - (2) No
 - 48a. If yes give reasons
 - 48b. If no give reasons
- 49. What measures do you take when you find your pigs are infected with a cyst?
 - (1) Would report to a veterinarian/livestock extension officers
 - (2) I will sell to businessmen
 - (3) I will slaughter and sell pork
 - (4) I will keep the pig
 - (5) Other measures
- 50. Is it safe to eat pork infected with a cyst?
 - (1) Yes
 - (2) No
 - (3) Don't know
- 51. What measures do you take when you find pork with a cyst?
 - (1) I will condemn and never eat
 - (2) I will cook properly and eat
 - (3) I will remove the cyst and cook
 - (4) Other measures
 -

Practices

- 52. Do you keep pigs?
 - (1) Yes
 - (2) No
- 53. How many pigs do you have in this household?
 -
- 54. Who is the owner of the pigs?

- (1) Father
 (2) Mother
 (3) Children
 (4) Whole family
 (5) Others (mention)
55. What is the aim of keeping pigs? (more than one answer is possible)
 (1) Business
 (2) Food
 (3) Business and Food
 (4) Other reasons (mention)
56. Where do you sell your pigs?
 (1) Local market
 (2) Market in nearby villages
 (3) Pig traders
 (4) Others (mention)
57. Who owns the income from pigs' sales?
 (1) Father
 (2) Mother
 (3) Children
 (4) Whole family
 (5) Others (mention)
58. Who takes care of the pigs?
 (1) Father
 (2) Mother
 (3) Children
 (4) Whole family
 (5) Others (mention)

59. How do you normally rear pigs during the daytime?
 (1) Confinement
 (2) Free roaming
 (3) Tethering
 (4) Others, mention
- 59a. If confining give reasons
60. How do you generally rear your pigs during the farming season:-
 (1) Confinement
 (2) Free roaming
 (3) Tethering
 (4) Others (mention)
- 60a. If confining give reasons
61. How do you generally rear your pigs after harvesting season?:-
 (1) Confinement
 (2) Free roaming
 (3) Tethering
 (4) Others (mention)

- 61a. If confining give reasons
62. What do you feed your pigs?
 (1) Leaves and other vegetables
 (2) Kitchen waste
 (3) Maize bran
 (4) Seed cake
 (5) Other feed (mention)
63. What problems have you encountered in pig management?
 (1) Cyst
 (2) Other intestinal worms
 (3) African swine fever (ASF)
 (4) Manges
 (5) No problem
 (6) Other problems (mention)
64. Do you think there are problems if pigs roam free?
 (1) Yes
 (2) No
 (3) Don't know
 64a. If yes, mention the problems
65. Have you ever slaughtered a pig at home?
 (1) Yes
 (2) No
- 65a. If "Yes", was the pork inspected?
 (1) Yes
 (2) No
- 65b. If not inspected what were the reasons?
 (1) Lack of transport for meat inspectors
 (2) High inspection fees for farmers to afford
 (3) Shortage of meat inspectors/public health workers
 (4) Difficult terrain
 (5) Vast area to cover
 (6) No need for inspection
 (7) Other reasons (mention)
66. Have you ever slaughter a pig in a slaughter house/slab?
 (1) Yes
 (2) No
67. If yes, is there a reliable water supply?
 (1) Yes
 (2) No
68. Do they have latrines in the slaughter slab?
 (1) Yes
 (2) No
69. Is there meat inspection during slaughtering?

- (1) Yes
 - (2) No
70. If yes who is doing the meat inspection?
- (1) Veterinary doctor
 - (2) Livestock field officer
 - (3) Health officer
 - (4) Other meat inspectors (mention)
71. Do you eat pork?
- (1) Yes
 - (2) No
72. Where do you prefer to eat pork?
- (1) Home
 - (2) Neighbours
 - (3) Pork centers in the village
73. If eating at home how do you prepare your pork?
- (1) Eating raw
 - (2) Cooking properly
 - (3) Cooking and frying
 - (4) Average cooking
 - (5) Other methods (mention)
.....
74. If eating pork can you identify cysts? (Show a clear coloured picture of cyst- infected pork)
- (1) Yes
 - (2) No
75. Do you wash vegetables and fruits before eating raw?
- (1) Yes
 - (2) No
 - (3) Sometimes
76. Do you use the toilet always?
- (1) Yes
 - (2) No
 - (3) Sometimes
- 76a. If no, give reasons
- 76b. If sometimes, give reasons
- Do you wash your hands after visiting the toilet?
- (1) Yes
 - (2) No
 - (3) Sometimes
- 77a. If yes, do you use soap?
- (1) Yes
 - (2) No
 - (3) Sometimes
77. Do you wash your hands before eating?
- (1) Yes

- (2) No
- (3) Sometimes

78a. If yes, do you use soap?

- (1) Yes
- (2) No
- (3) Sometimes

78. Where do you obtain water for family consumption?

- (1) River
- (2) Open well or river
- (3) Drilled well or tap
- (4) Other sources (mention).....

79. How do you treat water before drinking it?

- (1) Boil
- (2) Filter
- (3) No treatment
- (4) Others (mention).....

Appendix 21B: Household’s observation form Infrastructure & Behaviour

<i>To be filled in by the research team:</i>	
Date _____	Interviewer _____
District _____	Village _____

Latrine Infrastructure

1. Did you see a toilet in the household?

- (1) Yes
- (2) No
2. What is the floor made of?
 - (1) Soil
 - (2) Cement
 - (3) Other materials (mention):
3. Is the latrine wall complete?
 - (1) Yes
 - (2) No
4. Is the latrine roof complete?
 - (1) Yes
 - (2) No
5. Human faeces were found on the floor and around the latrine?
 - (1) Yes
 - (2) No
6. Where do children defecate?
 - (1) Pot
 - (2) On the ground
 - (3) Pampers
 - (4) Clothes/trousers
 - (5) Toilet
 - (6) Other places (mention)
7. Did the children's bottom cleaned after defecation?
 - (1) Yes
 - (2) No
 - (3) Didn't see
8. Hand washing facilities available at what distance
 - (1) < 5m from the toilet
 - (2) >5m from the toilet
 - (3) Absent
9. Water used to wash hands
 - (1) Tap water
 - (2) Shallow wells
 - (3) Bucket
 - (4) No water
10. Is soap available?
 - (1) Yes
 - (2) No
11. Type of toilet:
 - (1) Flush toilet
 - (2) Pit latrine
 - (3) Other (mention):
 - (4) Absent
12. How many latrines are there?
 - (1) 1

- (2) 2
 - (3) >2
 - (4) Absent
13. Where does the wastewater go to?
- (1) Underground septic tank
 - (2) Above-ground septic tank
 - (4) River
 - (5) Manure pit
 - (6) Other places (mention)
-
14. Overall impression of latrine:
-

Pig management

15. How do they normally rear pigs during the daytime?
- (1) Confinement
 - (2) Free roaming
 - (3) Tethering
 - 4) Others (mention)
16. What is the floor of the pigpen made of?
- (1) Soil
 - (2) Wood
 - (3) Cement
 - (4) Tiles
 - (5) Other:
17. Is the pigpen wall complete?
- (1) Yes
 - (2) No
- 17a. With what building materials?
- (1) Unburnt soil bricks
 - (2) Burnt soil bricks
 - (3) Wood/trees/mud
 - (4) Other materials (mention)
-
18. Is the pigpen roof complete?
- (1) Yes
 - (2) No
- 18a. With what materials was it constructed?
- (1) Corrugated iron sheets
 - (2) Thatched roof
 - (3) Wood
 - (4) No roof
 - (5) Other materials (mention)
19. Presence of feeders in the pigpen
- (1) Yes

- (2) No
- 20. Presence of drinkers in the pigpen
 - (1) Yes
 - (2) No
- 21. Overall impression of pigpen:
.....

Appendix 3C: FOCUS GROUP DISCUSSION

C1: Focus Group Discussion (FGDs) guide for village health committee (VHC) in Mbulu, Mpwapwa, Rungwe, and Mbinga Districts, Tanzania

Date _____

Village _____

District _____

Structure and description of the group

Name	Age	Gender	Occupation	Experience	Education
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

Introduction

Our interview aims to get enough information about intestinal worms (*Taenia solium*) to provide health education and how to reduce the transmission and spread of intestinal worms. And finally, come to evaluate the effectiveness of health education in controlling diseases caused by intestinal worms.

I would also like to remind you that in this discussion there will be no right or wrong answer. We would like to hear and know what each of you knows and thinks about our discussion today, so be free and open in expressing your views, regardless of whether you agree or disagree with what you hear from one another. It is very important that we hear all your views and perspectives. Please, when our colleagues speak let him/her finish without interrupting while they are talking even if we do not agree with their views. We can begin with each of us introducing ourselves.

Knowledge of Intestinal Worm (*Taenia solium*)

1. What are the committee's responsibilities in matters of health and environmental sanitation in the village? (Probing questions: what sanitation programs do you have? how do you implement them? how successful have you been? what are the challenges?)
2. What is the role of the health committee in facilitating communication between veterinarians/livestock field officers and pig farmers? (Probing questions, in what way? what is the response of farmers and livestock officers?)
3. Please tell us about the major health problems you face here in the village
4. Please tell us what measures pig farmers are taking to address the health problems of their pigs. (Probing questions such as; do they consult a veterinarians/livestock field officers? do they contact the committee? what communication channels are they using?)
5. Please tell us what measures the villagers are taking to deal with health problems.

6. Do you know the tapeworms (intestinal worms)? (Probing questions; where did you see the worms? from whom? how is it transmitted? Its symptoms, what is the treatment? how to prevent it? (Show participants a clear coloured picture of tapeworms)
7. Please tell us, what you know about human cysticercosis (Name the symptoms of the disease for participants to make it easier for them to provide information; how is it transmitted, its symptoms, treatment, and how to prevent)
8. Have you ever seen pork of this type? (Show participants a picture of pork infected with pork cyst (Probing questions like where did you see it? what action did you take? have you ever eaten such meat?)
9. Please tell us what you know about porcine cysticercosis (Mention symptoms of the disease to participants so that it is easier for them to explain; how is it transmitted, its symptoms, treatment, and how to prevent)
10. Please tell us what you know about human epilepsy (Probing questions; where did you get the information, its symptoms, how is it transmitted, what are the prevention measures, and its treatment).

Infections Risk

11. Where do pig farmers and pig traders take their pigs for slaughter? (Probing questions: why? what is the condition of the slaughter house/slab; are there toilets, is there a sewage system, is there enough water? this will be accompanied by the slaughterhouse/slab observation)
12. Is there a meat inspection at the slaughterhouse/slab? (Probing questions; who does the inspection? is he available on time? inspection costs? This will be accompanied by the slaughterhouse/slab observation)
13. Please describe the health effect of humans from eating pork infected with cyst (probing questions; what are the side effects? how can they be prevented?)
14. Have you ever had any deworming programmes in your village? (Probing questions; when was it done? What did it include? How was it implemented? What was its success?)
15. Have you ever had a program on general environmental sanitation, personal hygiene, and water sanitation and hygiene in the village? (Probing questions; when was it done? what did it include? how was it implemented? what was its success?)
16. From your point of view what methods can be used to end the problem of cysts and tapeworms in your village?
17. Do you have anything else you would like us to discuss here, or do you have any questions/additions/advice?

Summary and closing discussion

Thank you very much for your time and contributions to this discussion. We believe your contributions will be helpful to other Tanzanian communities as

well as in achieving the goals of this study. We will give you feedback on your contribution when it is ready without fail.

C2: Focus Group Discussion (FGDs) guide for Primary and secondary school science subjects teachers in Mbulu, Mpwapwa, Rungwe, and Mbinga Districts, Tanzania

Date _____

Village _____

District _____

Structure and description of the group

Nam	Age	Gender	Occupation	Experience	Education
-----	-----	--------	------------	------------	-----------

e					
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

Introduction

Our interview aims to get enough information about intestinal worms (*Taenia solium*) to provide health education and how to reduce the transmission and spread of intestinal worms. And finally, come to evaluate the effectiveness of health education in controlling diseases caused by intestinal worms.

I would also like to remind you that in this discussion there will be no right or wrong answer. We would like to hear and know what each of you knows and thinks about our discussion today, so be free and open in expressing your views, regardless of whether you agree or disagree with what you hear from one another. It is very important that we hear all your views and perspectives. Please, when our colleagues speak let him/her finish without interrupting while they are talking even if we do not agree with their views. We can begin with each of us introducing ourselves.

Knowledge on Intestinal Worm-*Taenia solium*

1. What health problem is the priority in your school? (Probing questions; explain, how much it affect school children, and how do you deal with it?)
2. What do you know about the tapeworms (*Taenia solium*)? (Probing questions; what do you know? where did you get the information? its symptoms, how is it transmitted? its treatment)
3. Please tell us what you know about human cysticercosis (HCC) (Probing questions; what do you know? Where did you get the information, its symptoms, how is it transmitted, its treatment)
4. Please tell us what you know about porcine cysticercosis (PC) (Probing questions; what do you know, Where did you get the information, its symptoms, how is it transmitted, its treatment)
5. Please tell us what you know about human epilepsy. (Probing questions; where did you get the information, its symptoms, how is it transmitted, what are the prevention measures, its treatment)

Infection Risk

6. Please tell us about the sanitary infrastructure in your school (Probing questions; does they meets the standards? what can be done to improve the infrastructure?). This will be accompanied by a personal examination of the school environment.
7. In your opinion, what are the areas where students are most susceptible to worm infections? (Probing questions; why? in what ways?)
8. In your opinion, what activities/behaviours are dangerous that lead to school children and other people getting infected with worms (tapeworms)?
9. What do you think school children should do to prevent worm infections?

Health education

10. Are health education subjects included in the primary/secondary school education curriculum? (Probing questions; in what ways? who will be responsible to teach? what subjects are taught? how many hours per week/semester?)
11. If the answer is no, do you plan to include health education in your curriculum? (Probing questions, in what ways? how long will it take? who will be responsible? what are the challenges?)
12. Please tell us how important health education is in your school. (Probing questions; do students need them? are there teachers? are there any health problems?)
13. What do you think can be done to prevent the transmission of tapeworms and cysts? (Probing questions; in what way? Who will be involved?)
14. What do you think about health education in schools?
15. How can health education on the tape worm be implemented in schools in a sustainable manner?
16. What should be included in the health education package? (Questions of probing; how should education be provided? who should be the main target? who will provide the education?)
17. Has there ever had a campaign against intestinal worms (tapeworms) in your school? (Probing questions; when was it done? how was it implemented? who implemented it? what topics were covered? what was the response of the students/teachers? was it successful or failed?)
18. Do you have a village health committee? (Probing questions; what are its responsibilities? how does it help the school children? have they visited your school? does it fulfill its responsibilities?)
19. What methods should be used to prevent worms and cysts?
20. From your point of view what methods can be used to end the problem? intestinal worms (tapeworms) to school children
21. Do you have anything else you would like us to discuss here, or do you have any questions?

Summary and a closing discussion

Thank you very much for your time and contributions to this discussion. We believe your contributions will be helpful to other Tanzanian communities and in achieving the goals of this study. We will give you feedback on your contribution when it is ready without fail

Appendix 1D: KEY INFORMANTS INTERVIEW (KII)

D1: Key informants interview guide: Agriculture/livestock extension officers and veterinarians

Introduction

Our interview aims to get enough information about intestinal worms (*Taenia solium*) to provide health education and how to reduce the transmission and spread of intestinal worms. And finally, come to evaluate the effectiveness of

health education in controlling diseases caused by intestinal worms (tapeworms).

Knowledge of Intestinal Worm-*Taenia solium*

1. What health problem is a priority in your village? (Probing questions; explain. how much does it affect residents? how do you deal with it?)
2. What do you know about tapeworms (*Taenia solium*)? (Probing questions; where did you get the information, its symptoms, how is it transmitted, how to prevent it, what is the treatment)
3. What do you know about human cysticercosis? (Probing questions; where did you get the information, its symptoms, how is it transmitted, how to prevent it, what is the treatment)
4. Please tell us you know about porcine cysticercosis (Probing questions; where did you get the information, its symptoms, how is it transmitted, how to prevent it, what is the treatment)
5. Please tell us what you know about human epilepsy. (Probing questions; where did you get the information, its symptoms, how is it transmitted, how to prevent it, what is the treatment)
6. Please tell us about the health problems that a person will get from eating pork with a cyst (Probing questions: what are the problems? how to prevent it, what is the treatment)
7. Please tell us what measures pig farmers are taking to address the health problems of their pigs. (Probing questions such as; do they communicate with veterinarian/livestock field officers? what communication channel do they use? Are they available on time, what is the average cost? is the cost affordable?)
8. What are the biggest problems facing pig farmers in your village? (Probing questions: what problems? why? what measures do you take?)

Infection Risk

9. How do most of the pig farmers rear their pigs during day time? When crops are in the field and after harvest (Probing questions: why? what problems will pigs have? what is your advice?)
10. Please tell us where do the pig farmers and pig traders take their pigs for slaughter. (Probing questions: why? are there toilets? Is there a sewage system, do they have hand washing facilities?)
11. Tell us what happens when pig farmers slaughter pigs at home? (Probing questions: is the meat inspected? By whom? what percentage consults the meat inspector for meat inspection? do they charge inspection costs? do farmers afford those costs?)
12. In your opinion, what activities/behaviours are dangerous and that put people at risk of being infected with tapeworms? (Probing questions: why? what can be done to prevent infection?)

Health education

13. Tell us if there has been any worm control program in your village (Probing questions: what was it about? what did it include? how was it implemented? was it successful or failed?)
14. Please tell us if there has been any program under government or external funding regarding environmental sanitation and personal hygiene in your village. (Probing questions: what was it about? what did it include? how was it implemented? did it succeed or failed?)
15. Please tell us your opinion about having health education for the community and other stakeholders (Probing questions: who will coordinate it? what topics should be included? who should be the target? what methods should be used? how long should education take? how many times should it be repeated per year?)
16. What other control strategies should be used together with health education to control *Taenia solium* cysticercosis/taeniasis (TSCT)?

Summary and a closing discussion

Thank you very much for your time and contributions to this discussion. We believe your contributions will be helpful to other Tanzanian communities and in achieving the goals of this study. We will give you feedback on your contribution when it is ready without fail

D2: Key informants interview guide: Environmental officers and community workers in Mbulu, Mpwapwa, Rungwe, and Mbinga districts, Tanzania.

Our interview aims to get enough information about intestinal worms (*Taenia solium*) in order to provide health education and how to reduce the transmission and spread of intestinal worms. And finally, come to evaluate the effectiveness of health education in controlling diseases caused by intestinal worms (tapeworms).

Knowledge of Intestinal Worm-*Taenia solium*

1. What health problem is your priority in your area/village? (Probing questions; explain? How much does it affect people? How do you deal with it?)
2. Please tell us what you know about the tapeworm (*Taenia solium*). (Probing questions; where did you get the information, its symptoms, how is it transmitted, how to prevent it, what is the treatment)
3. Tell us what you know about human cysticercosis (Probing questions; where did you get the information, its symptoms, how is it transmitted, how to prevent it, what is the treatment)
4. Please tell us what you know about porcine cysticercosis (Probing questions; where did you get the information, its symptoms, how is it transmitted, how to prevent it, what is the treatment)

5. Please tell us what you know about human epilepsy (Probing questions; where did you get the information, its symptoms, how is it transmitted, how to prevent it, what is the treatment)
6. Please tell us the health problems that a person will experience when eating pork with a cyst (Probing questions: what is the problem? how to prevent it, what is the treatment)
7. Please describe measures taken by the community members to deal with the problems caused by intestinal worms (tapeworms) (Probing questions such as; do they communicate with veterinarian/livestock field officers? what are communication channels used? Are they available on time, what is the average cost? is the cost affordable?)
8. What are some of the major health problems facing the residents of your area/village? (Probing questions: why? What steps do you take?)

Infection Risk

9. Please tell us under what circumstances people get infected with tapeworm infections more easily
10. In your opinion, what activities/behaviours are dangerous and that lead people to get infected with worms?
11. What do you think people should do to prevent tapeworm infections?

Health education

12. Tell us if there has been any intestinal worms (tapeworm) control program in your area/village (Probing questions: what was it about? what did it include? How was it implemented? was it successful or failed?)
13. Please tell us if there has been any program under government or external funding regarding sanitation and personal hygiene in your village (Probing questions: what was it about? what did it include? how was it implemented? did it succeed or failed?)
14. Please tell us your views on having health education for the community and other stakeholders (Probing questions: who will coordinate? what topics should be included? who should be the target of this education? what methods should be used? how long should education take? how often? how many times was it repeated)
15. What other methods/techniques should be used in addition to the provision of health education towards control of TSCT?

Summary and a closing discussion

Thank you very much for your time and contributions to this discussion. We believe your contributions will be helpful to other Tanzanian communities and in achieving the goals of this study. We will give you feedback on your contribution when it is ready without fail

D3: Key informants interview guide: health workers/practitioners'

Introduction

Our interview aims to get enough information about intestinal worms (*Taenia solium*) in order to provide health education and how to reduce the transmission and spread of intestinal worms. And finally, come to evaluate the effectiveness of health education in controlling diseases caused by intestinal worms (tapeworms).

Knowledge of Intestinal Worm-Taenia solium

1. What health problem is your priority in your area/village? (Probing questions; explain how much does it affect community members? how do you deal with it?)
2. Please tell us what you know about the tapeworm (*Taenia solium*). (Probing questions; where did you get the information, its symptoms? how is it transmitted? how to prevent, what is the treatment?)
3. Tell us what you know about human cysticercosis? (Probing questions; where did you get the information? its symptoms, how is it transmitted? how to prevent, what is the treatment)
4. Please tell us what you know about porcine cysticercosis. (Probing questions; where did you get the information, its symptoms, how is it transmitted, how to prevent it, what is the treatment)
5. What do you know about human epilepsy? (Probing questions; where did you get the information, its symptoms, how is it transmitted, how to prevent it, what is the treatment)
6. Please tell us about the health problems that a person will experience from eating pork infected with a cyst (Probing questions: what is the problem? how to prevent it, what is the treatment)
7. Please describe the measures taken by the community members in dealing deal with the problems caused by intestinal worms (tapeworms) (Probing questions such as; do they communicate with veterinarian/livestock field officers, through which communication channels, are they available on time, what is the average cost? Is the cost affordable?)
8. What are some of the major health problems facing the community members in your area/village of work? (Probing questions; why? what measures do you take?)

Infection Risk

9. Please tell us under what circumstances get infected with tapeworm infections more easily.
10. In your opinion, what activities/behaviours are dangerous and that lead people to get infected with worms?
11. What do you think people should do to prevent tapeworm infections?

Health education

12. Tell us if there has been any intestinal worms control program in your area/village (Probing questions: what was it about? What did it include? How was it implemented? Was it successful or failed?)
13. Please tell us if there has been any program under government or external funding regarding sanitation and personal hygiene in your village. (Probing questions: what was it about? What did it include? How was it implemented? Did it succeed or failed?)
14. Please tell us your views on having health education for the community and other stakeholders (Probing questions: who will coordinate? What topics should be included? Who should be the target of this education? What methods should be used? How long should education take? How often? How many times was it repeated)?
15. What other methods/techniques should be used in addition to the provision of health education?

Summary and a closing discussion

Thank you very much for your time and contributions to this discussion. We believe your contributions will be helpful to other Tanzanian communities and in achieving the goals of this study. We will give you feedback on your contribution when it is ready without fail.

Appendix 4: Health educational package

2.1 Health educational training of trainers (TOTs) manual

PREVENTION AND CONTROL OF *TAENIA SOLIUM* CYSTICERCOSIS AND TAENIOSIS IN TANZANIA

A Health Education Training of Trainers Manual

Nyangi CJ, Mkupasi EM, Ngowi HA, Mahonge C, Winkler AS



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and Research

1.0 INTRODUCTION 1.1 Background

Tanzania has a pig population of approximately 2.14 million (URT, 2020). Most of the pigs are reared in the traditional sector (Kimbi *et al.*, 2015). Pigs play a significant role, especially in small-scale enterprises where they play an important role in securing the livelihoods of rural communities and the availability of meat to rural and urban areas (Kimbi, 2015). The pork tapeworm, *Taenia solium* has been a problem in pig production in Tanzania for several decades, resulting in considerable socio-economic and health burdens (Ngowi *et al.*, 2019). *Taenia solium* is transmitted from a pig (intermediate host) to a human (final host) through consumption of infected pork and from a human to a pig or accidentally to another human (intermediate host) through the human faecal-oral route. Neurocysticercosis (NCC) manifested by epileptic seizures is the most dangerous form of *Taenia solium* infection in human while cysticercosis in pigs results in considerable economic losses due to pork condemnation. Important risk factors for *Taenia solium* infections are allowing pigs to roam, poor environmental sanitation and personal hygiene, inadequate meat inspection, and low knowledge on the lifecycle of the parasite. Based on previous studies conducted in the country, it is estimated that in 2012 Tanzania spent around 5 million USD to manage human epilepsy caused by *Taenia solium* and lost nearly 3 million USD due to condemnation of pork infected with *Taenia solium* (Trevisan *et al.*, 2017). Limited knowledge of *Taenia solium* transmission is the main obstacle to effective control of *Taenia solium* cysticercosis and taeniasis (TSCT) (Johansen *et al.*, 2014). It has been reported elsewhere that health education is important in the prevention and control of infectious diseases, TSCT inclusive (Alexander *et al.*, 2012; Johansen *et al.*, 2014; Ngowi *et al.*, 2017). The health education approaches that are participatory and engage the community in all stages of intervention development are likely to help individuals to take actions that would reduce and ultimately eliminate TSCT.

Considering that the transmission of TSCT is much linked with poor sanitation, combining water, sanitation and hygiene (WASH) practices with improved pig management practices, and other good practices could enhance control of TSCT in endemic settings (Gabriel *et al.*, 2016; Chard *et al.*, 2018). It is believed that several simple actions could prevent the transmission of TSCT and other infectious diseases and be practical even in economically challenging settings such as those of developing countries. This training manual guides the training and implementation of important WASH intervention activities and specific pig-related measures toward control of TSCT in Tanzania.

Between August 2008 and June 2019 TSCT transmission risk factors in Tanzania were assessed through an intensive literature review which was further augmented by the household survey, focus group discussions, and in-depth interviews in four districts namely Mbulu, Mpwapwa, Mbinga, and Rungwe. The first three districts were selected due to the presence of

smallholder pig farmers and porcine cysticercosis. The fourth district was selected for the reason that it was popular in pig production but the status of TSCT was unknown. Also, the districts represented different agro-ecological zones and cultural settings. A total of 12 focus group discussions with village health committees and science subject teachers from primary and secondary schools, and 38 key informants interviews with livestock/veterinary officers, health officers/practitioners, community development officers, environmental officers, ward and district educational officers (primary and secondary schools), head of primary and secondary schools and local government leaders were conducted. In addition, a questionnaire survey and direct observations of 483 households were conducted to assess the infection risk factors. The findings of these studies led to the identification of the following risk factors for TSCT:

- i. Drinking unsafe water and poor personal hygiene
- ii. Absence or poor conditions of the latrine/toilets
- iii. Limited use of latrine/toilets
- iv. Not washing hands with water and soap after visiting the latrine and before eating
- v. Not washing fruit and vegetables before eating
- vi. Insufficient cooking of pork
- vii. Allowing pigs to roam
- viii. Home slaughter of pigs without professional meat inspection
- ix. Selling or consumption of infected pork/pigs
- x. Not attending hospitals when sick

The obtained risk factors led to the development of key health education messages to be administered as an intervention package to the target communities for control of TSCT. Intervention foci were categorized as follows:

- (1) Improved WASH activities - risk factor (i) - (iv) addressed
- (2) Food safety and hygiene - risk factor (v) - (vi) addressed
- (3) Pig management and control - risk factor (vii) - (ix) addressed
- (4) Personal health - risk factor (x) addressed

Nevertheless, the authors understand that, necessary steps needed to be taken to enhance the effectiveness and sustainability of the targeted intervention taking into account potential local barriers to the implementation of recommended control measures. This was the driver for developing this detailed training manual.

1.2 Objectives of the Training Manual

The overall objective of this training manual is to facilitate the training of potential resource persons on how to educate and guide community members to implement measures for control of TSCT in their areas. Specifically, the manual: (1) educates participants on TSCT's impact and potential control measures, (2) guides on how to train the general community to implement WASH activities and (3) guides how to educate pig farmers to implement pig-

related measures for TSCT control. It is based on the principle that; new practices can be adopted and current practices are modified or changed slowly to directions acceptable by the community and useful to the control and eventual elimination of TSCT. This will in turn improve community health and well-being. This training manual is expected to complement and support other TSCT control strategies (e.g. human chemotherapy, pig chemotherapy and vaccination, proper pork inspection, and proper cooking of pork).

1.3 Organization of the Manual

For sustainability, community health education intervention for TSCT control will be implemented in two phases. The first phase will comprise the training of local communities' trainers. This will be followed by a second phase; training of the larger communities (villagers and school children) by the trained local trainers.

This training manual provides guidelines for the first phase of the intervention, training of trainers (ToTs), and it is divided into two modules, **Module I** is a two-day training workshop designed for training village and ward level health workers who usually conduct health education at the facility (health assistants, clinical officers, nurses, midwives, health educational officers), community development workers, primary and secondary school science (health) subject teachers, village/ward livestock field officers, animal scientists, village health committee (VHCs), and health volunteer workers. **Module II** is a two-day supplement to Module I. It includes all the material of Module I plus the essential sessions on the methods for implementing important TSCT control activities. This module will involve more practical than theory sessions. Toolkits (handouts with instructions for implementing various activities) are included in this training manual for all sessions to guide facilitators during lesson preparation and participant training. In any case, one training session will have a maximum of 30 participants to allow for optimal conversation and interaction.

The trained local trainers will follow similar procedures to train their local communities (second phase of the intervention). However, a simplified version of the manual for the local trainers to use has been produced. This consists mainly of the toolkits for the implementation of specific TSCT control activities.

1.4 Who Should Use the Manual?

This manual will be used first by trainers of local trainers (ToTs), the latter who will in turn use the same manual (but more simplified) to train the local communities. The ToTs team will comprise at least two persons, one of whom must be trained in or experienced with participatory approaches to learning in community or education programmes, and the second should be a veterinarian with a good background in TSCT. If possible, a Medical Doctor can also be included in a training team.

2.0 TRAINING PROGRAMMES AND RESOURCES

Training is divided into two modules, Module I and Module. Most of the training resources used in Module I are used in Module II with some additional materials for Module II.

2.1 Module I Training Programme at a Glance

DAY 1		DAY 2	
9:00-9:30	Session 1: Introduction to the Training	9:00-9:30	Recap of Day 1
9:30-10:30	Session 2: Why WASH Matters in controlling TSCT	9:30-10:00	Session 5: Keeping Drinking Water Safe from Source to Mouth
10:30-11:00	Tea Break	10:00-10:30	Tea Break
11:00-12:30	Session 3: Blocking Faecal Contamination	10:30-11:30	Session 5: Keeping Drinking Water Safe from Source to Mouth (cont)
12:30-1:30	Session 4: Hand Washing	12:30-1:30	Lunch Break
1:30-2:30	Lunch Break	1:30-3:30	Session 6: Improving Pig Management Practices
2:30-4:00	Session 4: Hand Washing		
4:00-4:4:30	Tea Break	3:30-4:00	Tea Break
4:30-4:45	Close	4:00-4:30	Evaluation and Closure

2.2 Module II Training Programme at a Glance

DAY 3		DAY 4	
9:00-10:30	Session 1: Water Treatment Methods (Practical)	9:00-9:30	Recap of Day 3
10:30-11:00	Tea Break	9:30-10:00	Session 3: Improving Pig Management Practices (Practical)
11:00-12:30	Session 1: Water Treatment Methods (Practical) cont.....	10:00-10:30	Tea Break
12:00-1:30	Lunch Break	10:30-1:00	Session 3: Improving Pig Management Practices (Practical) cont.....
1:30-3:30	Session 2: WASH and TSCT (Practical)	1:00-2:00	Lunch Break
3:30-4:30	Session 2: WASH and TSCT (Practical) cont.....	2:00-4:30	Session 3: Improving Pig Management Practices (Practical) cont.....
4:30-4:45	Tea Break		
4:45-5:00	Close	4:30-4:45	Tea Break
		4:45-5:00	Evaluation and Closure

2.3 Training Resources

In addition to the various sections of this manual, the manual provides 23 toolkits in the Appendix to be used during the training to guide the implementation of specific activities.

2.4 Evaluation of the Training

There are two questionnaires included in this training manual as toolkits in the Appendix. The first questionnaire (Toolkit 18) is for the evaluation of Module I. This questionnaire should be administered shortly before the training and immediately after completion of Module I. The second questionnaire (Toolkit 23) is for the evaluation of Module II. This second questionnaire should be administered only after completion of Module II training.

3.0 MODULE I: Training of Health Workers and Community Level Resource Persons

3.1 Objectives of Module I

1. To explain the basic concepts behind TSCT using a Lifecycle diagram and emphasize the control strategies along the life cycle;
2. To explain the basic concept of WASH and its importance for control of TSCT;
3. To explain basic WASH-related and pig related preventive measures for control of TSCT.

3.2 Workshop Sessions

This module is divided into seven sessions.

3.2.1 Module I Session 1: The Life Cycle of *Taenia solium* and Disease Control Strategies

Time (60 minutes)

Objectives of Session 1:

1. To explain the basic concepts behind TSCT using the lifecycle of *Taenia solium* with emphasis on the control strategies to safeguard human and pig health as well as improve income.
2. To discuss the economic and health consequences of TSCT.

Training resources

- Training Manual Section 3.2.1
- Toolkit 1

A: The Life Cycle and Control Strategies of Tapeworm (60 minutes)

Introduce the session by saying that in this session, we shall discuss the lifecycle of the tapeworm, and control strategies to interrupt the transmission cycle and economic and health consequences of the tapeworm.

TRAINERS NOTE

- This is the lifecycle of the pork tapeworm, *Taenia solium*. Let us start from the larval stage in pigs (*Toolkit 1*). Human tapeworm infection occurs when *Taenia solium* cysts are ingested from undercooked pork. The larvae attach to the human intestine and grow into adult tapeworms. The adult tapeworm then sheds segments (each of which has hundreds of microscopic eggs) into human faeces that can contaminate food and/or water/environment. Eggs ingested by pigs develop into the larval stage, travel via blood vessels to various body tissues, and develop into cysts/larva (Kraft, 2007).
- When humans ingest eggs, as in the case of pigs they become infected by the larval stage of the parasite and develop cysticercosis. Fecal-oral contamination usually occurs via infected food handlers who do not appropriately wash their hands before handling foods, through fruits and

vegetables fertilized by human waste or wastewater (sewage water or low-quality water).

- Ingestion of encysted pork causes intestinal infection in humans only by the adult tapeworm (a condition termed taeniasis).
- Even populations who do not eat pork (e.g., vegetarians) can develop cysticercosis. Cysts can lodge in the brain, eyes, skeletal muscle, and subcutaneous tissues.
- Neurocysticercosis characterized by epileptic seizures is a result of brain infection with larvae of *Taenia solium* while the invasion of internal structures of eyes can lead to blindness.

TRAINERS NOTE

Discuss with participants the health and economic impact of the tapeworm. Explain that when people eat undercooked meaty pork, they become infected with tapeworm, the worms develop inside the people, and can make them very sick with symptoms like; poor growth, rough grey hair, swollen belly, emaciation, and anemia. Children grow poorly because they lose nutrients, stunted children are not just shorter, but their brain function is also limited. They do worse in school, earn less, and are less resourceful and resilient to solve life challenges. Adults with human cysticercosis may develop neurocysticercosis which leads to complications such as severe headache, vision impairment, stroke/paralysis, and epilepsy.

Pigs left to free-range are exposed to infection with parasites such as *Taenia solium* from contaminated feed or water with *Taenia solium* eggs, which negatively affects production output through condemnation of infected carcasses and the zoonotic risk of the parasite to local communities. This also causes economic loss and affects pig farmers' livelihoods due to a reduction in the market value of pork.

When humans ingest eggs from foods or water contaminated with human faeces, they develop cysticercosis similar to pigs.

TRAINERS NOTE

Emphasise that it is very important to break the transmission of *Taenia solium* between human being and pigs to promote health and improve economic status of the community. Issues such as poor pig management, poor use of toilets, poor sanitation and hygiene, poor food handling and preparation, and poor WASH practices have a negative impact on health, growth, and economy of the community members.

Interventions that can be applied to stop the life cycle by stopping eggs from reaching the environment include the use and proper maintenance of latrines, treatment of taeniasis cases with praziquantel or niclosamide; treatment of pig cysticercosis; pig vaccination; building pigpens and always keep all pigs in the pens; immediately dispose of children's faeces in the pit latrine; thoroughly

wash hands after using latrines and before eating anything; boil water for drinking purposes; never eat or sell infected pork, and proper cooking of pork

B: How to Break the Tapeworm Life Cycle (30 Minutes)

Use of toilets	Pig management	Food handling	Sanitation and hygiene
<ul style="list-style-type: none"> • Proper use and maintenance of toilets • Hand washing facilities in toilets • Cleaning of toilets 	<ul style="list-style-type: none"> • Pigs confinement • Treatment and vaccination • Cleaning pig pen • Clean feeders and drinkers • Safe feed and water 	<ul style="list-style-type: none"> • Clean slaughter house/slabs • Pork inspection • Sufficient cooking of pork • Treatment of people with taeniasis 	<ul style="list-style-type: none"> • Handwashing after toilet and before eating • Treatment of drinking water

3.2.2 Module I Session 2: Introduction to WASH and its impact on TSCT control

Objective of Session 2

To introduce the concept of the WASH and its impact on TSCT control

Time 30 minutes

Training resources

- Training Manual Section 3.2.2
- A flip chart or PowerPoint slides outlining the three component of WASH programme
- **Toolkit 1**

An overview of the WASH programme

- Ask, participants what it means by the term WASH.
Possible answers - Water, Sanitation Hygiene, or hand washing. WA for WAter, S for Sanitation, H for hygiene or hand washing, all together, WASH

- Ask participants to provide reasons as to why WASH is important in TSCT control
- Provide an outline of the WASH programme with basic consideration in each of its three components - Water, Sanitation, and Hygiene
- Explain to the linkage between WASH and TSCT control
- Inform participants of some of the various targets for WASH activities and ask them what could be the barriers and suggested solutions for the implementation of such activities in their localities:
 - Use of improved latrines
 - Drinking safe water
 - Personal hygiene, including proper hand washing
 - General environmental hygiene

3.2.3 Module I Session 3: Basic Preventive Measures for TSCT

Time: 90 minutes

Objective of Session 3

- To explain the routes that faeces take from one person to another or from a person to pig as a result of open defecation.
- Explain possible health problems arising from ingestion of faecal material.
- To explain ways to block faecal contamination.

Training resources

- Training Manual Section 3.2.3
- Toolkit 2

A. Routes of Faecal Contamination (60 Minutes)

TRAINERS NOTE

This session can be done in small groups or in a plenary in an interactive discussion. Breaking into small groups takes more time, but allows participants to be more involved. Doing the exercise in the plenary saves time.

TRAINERS NOTE

This topic gets people thinking about and understanding the problem of open defecation and the importance of barriers (latrines, clean hands, safe water, and pigs' confinement) to fecal contamination.

1. Ask participants where most people take care of defecation. Women? Small children? Men? In fields? Why do people "go to the bush"? Do you think it is a problem? Why or why not? What are some bad things that can happen when people defecate in the open?

Possible answers:

- Faeces are dangerous to our health
 - Faeces get into our food, water, and hands and then into our mouths
 - Faeces get into feed, water, and then into animals (pigs) mouth
 - Faeces carry diseases and makes us sick
 - It's disgusting to see and very unpleasant to smell faeces
 - Flies jump from faeces to foods, drinks, and people's hands and lips
 - Embarrassment or assault on females
2. Ask participants 'what are some sicknesses you know that can come from contact with faeces?'

Possible answers:

- Diarrhoea/dysentery
 - Cholera
 - Worms
3. Ask participants 'what is so bad about *Taenia solium* cysticercosis?' Is it avoidable?'
 4. Ask participants 'who is the most vulnerable to infection with *Taenia solium* taeniasis?'

Possible answers:

- People eating undercooked pork
- People eating undercooked uninspected pork

5. Ask participants 'who are the most vulnerable to infection with cysticercosis?'

Possible answers:

- People not washing fruits and vegetables before eating
- People not washing hands after defecate and before eating
- People drinking untreated water
- Free roaming pigs

6. Tell participants that we have examined the problem of the practice of open defecation and begun to look at what the consequences are of this behaviour on the health and well-being of people and animals.

Remind participants that faeces left in the open mean that: **EVERYONE IS EATING EACH OTHER'S FAECES!**

7. Show participants the picture of the person practicing open defecation (**Toolkit 2**) and ask:

- What happens when someone defecates in the open?
- Where do the faeces go?
- What happens when it rains?
- How do the faeces get from this person or that place into our mouths to make us sick?

Possible answers

- The rain carries faeces into fields and streams and ponds.
- People drink contaminated water.
- People can walk through fields and track the faeces into homes.
- Flies can land on the faeces and then land on food.
- Hands can touch the faeces and then touch others, or touch food.
- Roaming pigs may eat human faeces directly or via contaminated feed or water

B. Five Tools to Block Faecal-Oral Contamination (30 Minutes)

1. Ask the group to review behaviours that can block faecal-oral contamination? Elicit responses from the group.
2. Explain that there are FIVE KEY Behaviours we will focus on to block faecal-oral contamination. Emphasize that this is the foundation of our work.

TRAINERS NOTE

Proper use of latrines/toilets
 Correct hand washing with soap at key times
 Treating, storing, and drinking water safely
 Practicing safe food hygiene
 Practising pig confinement (pig management)

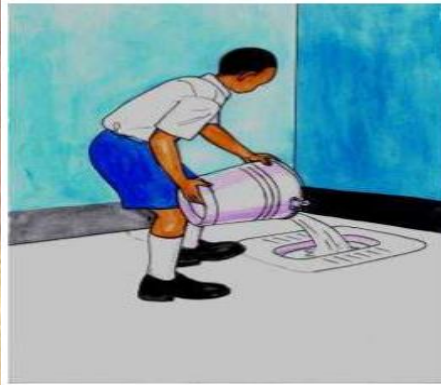
Proper use of latrines

There are three main types of latrines; pit latrines, ventilated improved pit latrines (VIPs), and pour-flush latrines (URT, 2016). For schools and households in areas where no or insufficient water for flushing is available close

to the latrine or where poor facilities are used for cleaning, the VIP latrine is the most suitable. If a sufficient amount of water is available close to the latrine and the facilities are expected to be well maintained, a pour-flush latrine may be considered. Although these three latrine types are recommended, there is a range of options available for schools and households, and any latrine is better than no latrine.



Figure 5: (a) Pit latrines



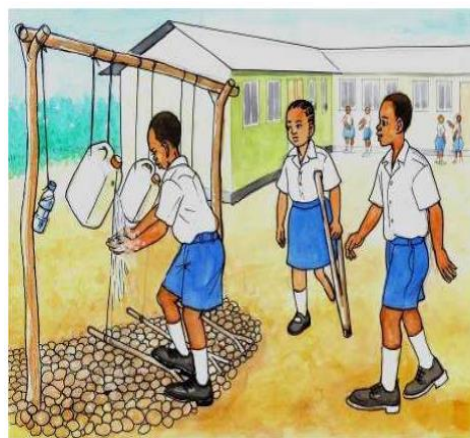
(b) Pour latrines



(c) Improved Pit Latrine for schools (no vent pipe)



(d) VIP latrines



People should always use sanitary latrines and washing hands with soap after visiting latrines. **Source: URT, 2016**

3.2.4 Module I Session 4: Hand Washing

Time: 150 minutes

Objectives of Session 4:

- i. Explain the reasons for hand washing and critical times to practice it
- ii. Demonstrate the correct way of washing hands
- iii. Explain critical times to wash hands
- iv. Build a tippy tap from locally available materials

Training resources

- Training Manual Section 3.2.4
- **Toolkit 3**
- **Toolkit 4**
- **Toolkit 5**

A. Importance of Washing Hands (40 Minutes) - Theoretical

Inform participants that, hands are used for many dirty works such as anal cleansing after defecation. No matter what material is used for anal cleansing, hands still get contaminated from the faeces, even if the faeces cannot be seen or smelled. Hands should be washed after using the latrine or toilet and before handling or eating any food. Both hands should be washed thoroughly with running water and a detergent (**Toolkit 3**). Soap is the most effective hand washing agent. When soap is too expensive or not available, the following alternatives can be used:

- Wood ash will also lift and rub off any dirt and smells. The slight irritation you feel when you wash your hands with ash shows the cleansing power of ash;
- Clean sand with water can be used for hand washing to help rub off dirt.

B. The Correct Way to Wash Hands (40 Minutes) - Demonstration

1. Emphasize the importance of the hand washing procedure. In the washing process, the soap or ash lifts the dirt and germs, breaks up seen and unseen filth on the hands, and the water then flushes it away when the hands are rinsed. Water must be flowing to make sure that you do not re-contaminate your hands. Rubbing hands together is important, too.
2. Ask what are the correct steps to hand washing and write up the list on the chart. The list might look like the one below:

How to Wash Hands Correctly

1. Wet hands with running water;
2. Apply soap (or ash in case of no soap);
3. Rub your hands together vigorously to produce foam. Rub the backs of hands, between fingers, under fingernails, and wrists. Do the rubbing for at least 20 seconds (or 10 times);
4. Rinse away all the soap/ash with running water;

5. Dry hands using a disposable paper towel or if not available let the hands dry naturally in the air. Do not use any cloth to dry your hands as it may contain disease-causing agents.

2. Direct the participants to **Toolkit 3: How to Wash Hands Correctly**. Mention that this toolkit is the same as one of the job aids they will use to help community members wash their hands correctly.

C. Critical Times to Wash Hands (40 minutes)

1. Think about what it means for a typical family to improve their handwashing practice and wash their hands correctly at all times. First, let's review together what we call the "critical times" for hand washing (**Toolkit 4**).
2. Ask participants 'what are the critical times we should wash hands?'

Possible answers:

- After using the toilet
- Before eating or feeding someone
- Before breast-feeding
- Before preparing food
- After changing a nappy

D. Making a Tippy Tap for Hand Washing (30 Minutes)

1. Explain that it is difficult to do correct hand washing without running water.
2. Ask the group if they think most homes would be able to provide that amount of water just for hand washing? Explain that we will learn how to build a hand washing device a tippy tap to help wash hands at critical times even when water is scarce or where there is no tap for running water. This is a simple technology to make hand washing easier.
3. Show a sample tippy tap. Demonstrate quickly how it works. Do not demonstrate a complete hand wash but rather describe the basic benefits and how it works. Say, look you have it handy; you open and close it like this; it works like a tap that's why we call it a tippy tap; it's right here in front of you, so it helps you to remember to wash and then makes it easy to do.
4. Pass out **Toolkit 8: Instructions for Making a Tilting Jerry Can Tippy Tap** and **Toolkit 9: Instructions for Making Other Types of Tippy Taps**. Talk through each picture of the different types of tippy taps. Ask the group if anyone has ever made or used a tippy tap before. How was it constructed?

3.2.5 Module I Session 5: Water Safety Chain

Time: 90 minutes

Learning Objectives

Objectives of Session 5:

1. Identify the links in the Water Safety Chain
2. Describe how to keep water safe at each "link", from source to mouth

Training Resources

- Training Manual Section 3.2.5
- **Tool kits 6 - 9**

A. **Water Safety Chain (45 Minutes)**

1. Explain that we have learned about the problem of defecating in the open, how to block the “F” routes, and have looked extensively at one of the four key practices, hand washing. Now we will learn another way to break the fecal-oral cycle, which is another way to block faeces from entering our food and water. We will learn about keeping water safe from source to mouth, and how we can ensure that our homes have safe drinking water for the whole household.
2. Ask for volunteers to answer the following questions (these are **current practices**):
 - Where they get their water (what **source or supply**)
 - How they **transport** water from the source to their home
 - How they **store** drinking water at home
 - How they **serve** drinking water at home – where they store it their mouth

TRAINERS NOTE

If participants all have running water, ask them to also think about the communities they serve.

3. Explain that these are links in what we call the Water Safety Chain (**Toolkit 6**), and each part needs to be protected from faeces contamination to make it safe. It is called the Water Safety Chain because if safety breaks down at any one link in the chain, the water is no longer safe for drinking.
4. Direct participants to **Toolkit 6** and **Toolkit 7** on Water Safety Chain and ask the groups to label the key links (supply, transport, storage, and serving) on the handout.

B. **Ensuring Water Remains Safe to Drink (45 Minutes)**

1. Ask the group the following questions and make sure the key points from the chart and box below are discussed. Concerning Toolkit 8 and Toolkit 9 key actions are discussed like how to keep water safe, and how to wash containers etc.
 - How can dirt and faeces enter the water at the different points in the water chain and contaminate it? These are some of the factors that influence safe water behaviours.
 - What can you do at each point in the water chain that will prevent faeces from making the water “bad” or unsafe to drink? These are small doable actions.

- Make a chart on a flip chart capturing potential ways in each “link” that water could be contaminated, and then a few small doable actions to make it less risky, in other words, to better protect the water (refer to the chart below).

Steps in the Water Safety Chain	Small Doable Actions to Keep Water Safe
Supply of Water	Protect the source: If a well or standpipe <ul style="list-style-type: none"> • Build a fence so animals cannot defecate nearby • Build a raised platform and/or a soak pit • Wash hands with soap before collecting water • Do not put your hand into the container when collecting water. If an open source or stream: <ul style="list-style-type: none"> • Assure no animals or humans defecate upstream
Transporting Water	<ul style="list-style-type: none"> • Use a narrow neck container • Cover container • Attach the cover to jerry can with a string so it doesn't get lost/stolen. • Punch a small hole in the center of the top. Thread with string and knot. • Tie another end of the string to the neck of the container, short enough so the top doesn't touch the ground • Make a top with a clean potato or other objects that can be washed • Do not stick hand into container when carrying
Storing Water	<ul style="list-style-type: none"> • Maintain water in the narrow neck, covered container • Raise container off floor
Serving Water	If no spigot on container: <ul style="list-style-type: none"> • Pour water for use • Make a simple dipper/ladle for serving from a calabash or a can and stick. Hang on wall • Use a mug with a handle to serve. Do not have hands touch water. • Store in a dedicated, clean place

Key Points for Discussion

TRAINERS NOTE

1. Source of water: Some water sources such as rivers, unprotected springs, or wells are already contaminated or have the potential to be contaminated. If a river is the only source, water should be collected upstream from any washing or bathing of people or animals. A well or spring should be fenced to keep animals away. The collection bucket and rope should be kept off the ground.
2. Water fetching containers: Water can also be contaminated if water containers such as clay jars, jerry cans, etc. are not cleaned properly. Ask how often and what methods people use to clean their containers. Explain that proper washing includes filling the container about 1/4 full with water and soap or a little bleach, swishing it around the container, letting it sit for at least 20 minutes, and until no soap or bleach is left, and finally drying the container in the sun. No cloth, rag, or hand should ever enter inside the jerry can. For open containers like buckets, wash hands with soap FIRST and then hands can be used when cleaning wide-mouth containers.
3. Safe transport to the home: Even if it is fetched from a safe and protected source, water can also be contaminated during transportation. Be certain to cover all containers properly using clean covers or screw caps. A covered jerry can is the best. Open buckets are easy to contaminate and should be replaced by covered containers. Caps can be secured to the jerry can by using a 35 cm or so string. Tie one end around the jerry can neck and secure the other end to the lid by punching a hole through the inside of the lid, threading the string through the hole, and tying it off with a knot
4. Storing water at home: Water can also be contaminated at home when it is left open where animals can drink it and children can dip their hands in it. The safe way is to store it in a narrow-necked container that can be covered with a screw cap or a hardcover. A clean jerry can is also a safe storage container.
5. Serving water at home: Use a clean dipper or ladle that is hung on a nail when not in use.
6. Drinking vessel: Use your clean cup. If you share your cup, you'll share your germs!

3.2.6 Module I Session 6: Improving Community health and Pig Management

Time: 120 minutes

Objectives of Session 6:

- i. Describe different options for pig confinement
- ii. Mention different pig feed ingredients available locally
- iii. Discuss plans for good management of confined pigs
- iv. Describe the importance of having toilets in each h/hold

- v. Describe safe pig slaughtering practices.

Training resources

- Training Manual Section 3.2.6
- **Toolkits** 10 - 17

A. Indoor pig management system (40 Minutes)

1. Now we will learn another way to break the faecal-oral cycle, which is another way to block faeces from contaminating pigs. We will learn about pig's confinement and how we can ensure that pigs are safe from feed and water contaminated with tapeworm eggs (**Toolkits** 16 and 17).
2. Explain that there is a linkage between pig management and TSCT infection. It is advantageous to practice good pig management (confinement, feeding, and disease control) in an effort to control TSCT.
3. Direct participants to (**Toolkit** 2): Tapeworm life cycle. And as a group, labels the key points along the cycle using paper stickers that can be removed as needed.

TRAINERS NOTE

Pigs' confinement

Pig confinement will prevent pigs from access to human faeces containing tapeworm eggs and getting cysticercosis. Confinement will also reduce environmental contamination as the pigs defecate and damage neighbors' crops and other properties. It will also reduce outbreaks of other fatal diseases such as African swine fever.

Sanitation and hygiene in pig pens should also be maintained. It is very important that the pigpen is clean at all times and constructed to allow easy cleaning. The pigpen should have durable floors (concrete or wood), walls, roofs, and necessary facilities for feeding and watering pigs in a hygienic manner. Feed and drinking water should be free of contamination from human faeces.

B. Pig feeding (50 Minutes)

1. Direct participants to **Toolkit** 18 that presents different pig feeds and make sure that the following are discussed:
 - Feed requirements for pigs.
 - How can pigs be properly fed to maximise productivity at a reasonable cost while in the confinement.

TRAINERS NOTE

Confined pigs (housed, fenced, or tethered) must be fed daily and this takes time and resources. Feeds should meet the animal's needs for maintenance, growth, and reproduction. Good pig feed contains sufficient energy, protein, minerals, and vitamins. Farmers who were practicing the free range system must be taught about the locally available foods that can be used in combination to provide a complete ration for the pigs.

Energy sources include maize (bran, whole grain), wheat (bran and pollards), brewer's spent grain, rice (bran, polishings, pollards), and local brew dregs/draft cassava (dry, fresh).

Protein sources include fish meal, blood meal, meat, and borne meals, cotton seed cake, sunflower cake, coconut cake, kapok (msufi in Swahili) cake, palm cake, other oil cakes and legumes such as common beans. The latter should be boiled before being fed to pigs.

Miscellaneous feeds include swill (kitchen leftovers, curl fruits and vegetables (e.g. pawpaw, pineapples, pumpkins, mangoes, bananas, tomatoes, avocados, amaranthus), root tubers such as cocoyams (should be fed to pigs after they are cooked), weeds and herbaceous forages (a variety of pasture). They are good sources of vitamins and minerals. Pigs should be fed on forages daily as supplements as the protein quality and quantity in these feeds are limited. Also note that above named energy and protein food sources also provide some minerals and vitamins (Lekule, 1996).

C: Pig health (30 minutes)

Preventive measures that reduce the probability of health problems and allow better control of diseases once they occur should be promoted actively through training and extension. Among others, this includes vaccination protocols and on-farm biosecurity measures. Confinement of animals and limiting their access to waste, human faeces, other livestock, or wildlife will reduce the possibility of disease spreading and allow better control of the animals' performance making timely disease detection more likely to happen (FAO, 2012). To date, no vaccine has been commercially available for use against TSCT. Though, the vaccine is under trial in Tanzania. Therefore, implementation of WASH and improved pig rearing practices are the most advocated preventive measures for TSCT.

D: Improving food safety and hygiene

Time: 60 minutes

The objectives of this sub-session are to:

- i. Explain the need for controlled pig slaughtering with professional meat inspection
- ii. Describe adequate cooking of pork
- iii. Explain the importance of washing fruits and vegetables for human consumption
- iv. Explain the problem of selling or consumption of infected pork/pigs

E: Adequate cooking of pork (30 min)

Ask participants to describe how they cook pork

Possible answers:

- Cooking (boiling)
- Frying
- Barbequing (roast on an open fire)

- Boiling and frying

TRAINERS NOTE

Discuss with participants the health and economic consequences of eating inadequately cooked infected pork. Explain that when people eat inadequately cooked infested pork, they become infected with tapeworm, the worms develop inside the people, and can make them very sick with symptoms like; poor growth, rough grey hair, swollen belly, emaciation, and anemia. Children grow poorly because they lose nutrients, stunted children are not just shorter, but their brain function is also limited. They do worse in school, earn less, and are less resourceful and resilient to solve life challenges. Adults with human cysticercosis may develop neurocysticercosis which leads to complications such as severe headache, vision impairment, stroke/paralysis, and epilepsy.

Pigs left to free-range are exposed to infection with parasites such as *Taenia solium* from contaminated feed or water with *Taenia solium* eggs, which negatively affects production output through condemnation of infected carcasses and the zoonotic risk of the parasite to local communities. This also causes economic loss and affects pig farmers' livelihoods due to reduction in market value of pork. When humans ingest eggs from foods or water contaminated with human faeces they develop cysticercosis similar to pigs.

F: Importance of washing fruits and vegetables for human consumption (30 min)

Ask participants why is it important to wash fruits and vegetables to be eaten raw?'

Possible answers:

- Remove dirt (soil remains)
- Remove microorganism
- Remove worm's eggs

TRAINERS NOTE

Discuss with participants the importance of washing fruits and vegetables to be eaten raw. Explain that washing is very important as it removes all dirt on the surface including Tapeworm eggs if present. Emphasize that this practice will help to control contamination with tapeworm eggs to humans.

Washing should be done with clean and safe running water to avoid recontamination.

G: Slaughter of pigs at a centralized slaughterhouse with proper meat inspection

In most rural areas' pigs are slaughtered in slaughter slabs or on top of bare ground or in household compounds with little concern for welfare or hygiene, often with no official inspection. The inspected meat ensures that all infected pork does not enter the market and infect people, this will ensure that no infected pork will be sold or consumed by the population. When people eat infected improperly cooked pork they will become infected with tapeworm and lead to several health problems but also will later infect other people or pigs with cysts through open defecation or unhygienic behaviour (not washing hands with soap after visiting the toilet and before handling food). Slaughtering pigs in a good, clean and hygienic slab with all the facilities available will also ensure that the pork will be safe for consumers

1. Ask participants if they have slaughter slabs in their respective areas.
2. Ask participants 'what are the attributes of a good slaughter slab.
(Toolkit 19)

Possible answers:

- Presence of toilet
- Presence of cleaning water
- A slab with cemented floor
- Presence of drainage system
- Good hygienic and safety conditions
- A slaughter slab with a fence

TRAINERS NOTE

- Discuss with participants the attributes of a good slaughter slab from their answers
- Ask participants what to be done to construct slaughter slabs for those without slaughter slabs and how to improve slaughter slabs

H: Human Health Management

People should always visit health centers once they feel sick. Explain that when people eat undercooked pork infected with the cyst, they become infected with tapeworm, the worms develop inside the body, and can make them very sick with symptoms like; poor growth, rough grey hair, swollen belly, emaciation, and anemia. Children grow poorly because they lose nutrients, stunted children are not just shorter, but their brain function is also limited. They do worse in school, earn less, and are less resourceful and resilient to solve life challenges.

When humans ingest eggs from foods or water contaminated with human faeces, they develop cysticercosis similar to pigs. Adults with human

cysticercosis may develop neurocysticercosis which leads to complications such as severe headache, vision impairment, stroke/paralysis, and epilepsy. People infected with tapeworm can be treated at health centers with praziquantel/niclosamide. Encourage people or relatives with epileptic signs/symptoms to also visit the hospital for treatment instead of visiting traditional healers.

3.3 Module I Evaluation (15 minutes)

1. Ask the participants to fill in the evaluation questionnaire for Module I provided (**Toolkit:** 18) as it was done before the module training started.
2. Participants should be reminded to put the same names they used before the training.

TRAINERS NOTE

Collect the completed evaluation forms and carry out analysis of the participants' responses. Where possible, give feedback. Include this analysis in your training workshop report!

4.0 MODULE II: Practical Integration of WASH into TSCT Control Programmes

4.1 Overview

Duration: 2 days

Target

Module II is a two-day supplement to Module I, it includes the material of Module I plus the essential sessions for practical demonstrations of important WASH, pig, and human-related activities necessary for TSCT control that are manageable at the community level. All participants of Module I are eligible to participate Module II training.

4.2 Objectives of Module I

1. Demonstrate different WASH activities useful for TSCT control
2. Demonstrate some pig and human-related interventions useful for control of TSCT
3. Demonstrate compounding of pig feed using locally available ingredients

4.3 Sessions

4.3.1 Module II Session 1: Drinking Water Treatment Methods

Time - 180 minutes

Objectives of Session 1:

1. Demonstrate the different methods for making water safe for drinking
2. Describe the advantages and disadvantages of each method

Training resources

- Training Manual Section 4.3.1

- Toolkits 19 - 22
- Additional material may be needed under each specific procedure

A. Prior preparation of water by filtration (30 minutes)

1. Usually, many households have water that is not clear (has observable particles), particularly during the rainy season. Some water can be turbid (chocolate colour or dirty-looking). For such water, before treatment, it is important to get the particles out first. We will now learn how to get the dirt out of the water before it is treated. When water is turbid, the treatment methods don't work well, so in these cases, it is essential to filter the water first.
2. Review the two methods for filtering dirt out of the water as described below:

Check for "Dirt" and Remove the "Dirt"

Fill a container with untreated water. Determine if the water is clear enough or if it looks muddy or cloudy. If your water looks muddy or cloudy, then you need to remove the dirt by one of two methods.

1. Remove the 'Dirt' with a Cloth (Filtering):

- Pour the water through a clean piece of cloth (tightly woven with no holes in it) that is placed over the opening of a clean container. The dirt will get trapped by the cloth. After filtering your water, put the dirt that collected on the cloth where children and animals cannot get to it, such as in a latrine or buried in a hole. After dumping the dirt, wash the filter cloth and dry it in the sun.

2. Let the 'Dirt' Go to the Bottom and Pour Out the Clear Water (Settling and Decanting):

- Let the untreated water sit untouched for 12 hours so that the dirt settles to the bottom of the container while the clear water remains at the top of the container. Then pour (or decant) the clear water into a second, washed container while leaving the dirt behind in the original container. Throw away the dirt or residue remaining in the first container by rinsing the container and tossing the soiled residue where children and animals cannot get to it, such as in a latrine or buried hole.

3. Explain to participants that any tightly woven cloth can be used for this pre-treatment step as long as it is clean, without holes, and big enough to cover the opening of the container into which the water is being poured.
4. Ask for a volunteer to help you demonstrate how to filter dirty water using the two methods described above.

B. How to boil and store water for drinking

Time: 30 Minutes

1. Make sure that the water is free of any objectionable materials before boiling. This can be done through sieving.
2. Tell participants 'we will now review how to boil water'. Ask the group:

- For how long do you boil water?
 - What type of fuel do you use to boil your water?
 - What type of container do you use to boil your water?
3. Make sure the main points are covered in your discussion on boiling water and direct participants to refer to **Toolkit 19: How to Boil and Store Water**.
- Boiling is a way to make water safer for drinking.
 - Boiling is a method that can be used on clear and very turbid (muddy, cloudy) water. Most people prefer to remove the dirt before boiling to make the water look and taste better finally.
 - Water needs to be heated until **LARGE BUBBLES** appear, not just the small bubbles on the side of the container.
 - After the big rolling bubbles appear, you can stop boiling. There is no need to keep boiling for more minutes **AFTER** the big, rolling bubbles.
 - Care must be taken not to re-contaminate the water once it has been boiled.
 - Cool the water while covered, which takes longer but keeps it safe.
 - When cool enough, transfer to another clean and prepared container.
 - The boiled water must be placed in a secure storage container, preferably with a lid and spigot to avoid recontamination. If the water is stored and served properly, it is safe to drink for 24 hours after it is treated. After 24 hours, the water is likely to be re-contaminated and needs to be replaced with newly boiled water.
 - Do not add “new” boiled water to “old” boiled water, meaning that you should empty your storage container of “old” boiled water before adding a batch of “new” one. The “old” boiled water can be used for household work like washing clothes and dishes or for watering the plants or can be boiled again.

TRAINERS NOTE

Boiling water is a water treatment method that is known to be more widely available than chlorination. However, fuel may not be cheaply available, as it can have a substantial cost associated with it. Participants, their clients, and their household members need to choose the appropriate method of water treatment according to their household situation. The biggest consideration is that boiled water can easily be re-contaminated, often even before the treatment process is complete.

C. Solar Disinfection of water

Time: 60 Minutes

1. Tell participants that the cheapest way to disinfect water is to use the sun. Ask if anyone knows how to treat drinking water using the solar disinfection (SODIS) method.
2. Ask the group:
 - What type of bottle should you use?
 - What steps do you follow?

- How long does the water have to sit under the sun to be treated?

3. Make sure the main points are covered in your discussion on solar disinfection:

- Use transparent plastic water or soda bottles that are 1-2 litres in size. Make sure the lid of the bottle closes and the bottle does not leak.
- Clean the inside and outside of the bottles.
- Fill the bottle 3/4 full with non-turbid water to be treated.
- Shake the bottle for about 60 seconds (to aerate the water, putting more oxygen in the water)
- Fill up the bottle completely and screw the cap back on.
- Lay the bottles on a flat surface and make sure they are exposed to the sky, unblocked. In the bright sun, the water is “treated” in 6 hours. If there are 50% or more clouds, the water will need to sit exposed to the sky for two days to be treated, even if the sun wasn’t shining. Solar disinfection is NOT very effective in the rain and it is less practical on a large scale.
- Direct participants to **Toolkit 20**.
- You can only use the SODIS method with clear water.
- You cannot treat turbid (murky or dirty) water with the SODIS method. If the water is turbid, the chlorination method or the boiling method should be used.

Important notes:

- After opening a bottle of water treated with SODIS, it should only be kept for 24 hours after that, it should be discarded.
- You should not drink water treated with SODIS directly from the bottle. To drink the water, pour some in a clean glass or cup.
- You cannot use the SODIS method if it is raining all day long because there will be not enough sunlight to reach the water.

D. Chlorination of water

Time: 45 minutes

- Describe to the participants the steps on how to use WaterGuard Liquid and direct them to **Toolkit 21**.
 - Describe the steps on how to use WaterGuard Tablets while you read them out loud and direct them to **Toolkit 22**.
4. Explain to participants that there are a few important points that should not be overlooked when water is treated with chlorine. These include:
- Care not to re-contaminate the water once the product has been added. Treated water must be placed in a secure storage container, preferably with a lid and cork to avoid recontamination. If the water treated with chlorine is stored and served properly, it is safe to drink for up to a week after it is treated.

- One advantage of the chlorine products is that they keep re-disinfecting water for at least 24 hours (if no additional water is added which dilutes or weakens its ability to re-disinfect).
- It is very important to check the expiration date on the package and to NOT use the product after it has expired.
- The bottle WaterGuard Liquid solution is good for 30 days after it has been opened. After 30 days, an opened bottle of WaterGuard Liquid solution should be discarded.
- Water treated with chlorine can be kept and drunk for up to one week when it is stored in a narrow neck container with a tight-fitting lid. If it is stored in a wide- mouth container or without a lid, it can only be drunk for up to 24 hours.

E. Advantages and Disadvantages of the Different Methods of Water Sanitation (15 Min)

Treatment Methods	Advantages	Disadvantages
Boiling	<ul style="list-style-type: none"> • Every home and probably every school has a place to boil water • It's cheap (if firewood/charcoal is cheap) • It's effective-boiling kills everything 	<ul style="list-style-type: none"> • Uses wood that may be scarce • Water can get re-contaminated after boiling when it is poured into another storage container • Not practical for a school • Possibility for contamination • Not ready for immediate drinking, must be cooled
Solar Disinfection	<ul style="list-style-type: none"> • It's very cheap • It's effective • Easily Available 	<ul style="list-style-type: none"> • Takes a long time to treat the water • Takes even longer if it is not a sunny day
Chlorine	<ul style="list-style-type: none"> • Very effective • Leaves germ-killing residue in water • A little goes a long way • Easy to administer 	<ul style="list-style-type: none"> • Product might be too costly for large communities • Product might not be easily available • Some methods take longer to treat than others

Remember: *The chlorination method is considered to be the "ideal" method (as residual chlorine protects the water). While boiling and SODIS treat water just as well as chlorine, they are considered "less than ideal" (because there is no element that remains in the water to protect it from recontamination).*

4.3.2 Module II Session 2: Making a Tippy Tap for Hand Washing

Time: 90 Minutes

Training resources

- Training Manual Section 4.3.2
- **Toolkit 5a** and **Toolkit 5b**
- Additional material:
 - An empty plastic 1 or 1.5 litre water bottle, a gourd, or a five-litre jerry can.
 - A pen casing, a papaya stem, a straw or anything that is hollow
 - A sharp knife, a nail, and candle, or a screwdriver to make a hole in the vessel for the tube

A. Each group to make a different type of tippy tap

1. Explain that it is difficult to do correct hand washing without running water.
2. Ask the group if they think most homes would be able to provide that amount of water just for hand washing. Explain that we will learn how to build a hand washing device; a tippy tap to help wash hands at critical times even when water is scarce or where there is no tap for running water. This is a simple technology to make hand washing easier.
3. Show a sample tippy tap. Demonstrate quickly how it works. Do not demonstrate a complete hand wash but rather describe the basic benefits and how it works. Say, 'look! you have it, handy; you open and close it like this; it works like a tap that's why we call it a tippy tap; it's right here in front of you, so it helps you to remember to wash and then makes it easy to do'
4. Direct participants to Toolkit 5a and Toolkit 5b. Talk through each toolkit of the different types of tippy taps. Ask the group if anyone has ever made or used a tippy tap before. How was it constructed?

B. Group Activity

1. Divide the participants into four or five subgroups and have each group make a model tippy tap. Encourage groups to be innovative.
2. Provide each group with the required materials to make a tippy tap:
3. Explain carefully to the groups how to make a tippy tap. You can also write up instructions on a flip chart.
4. Let each group make a different type of tippy tap. The facilitator should also make one for demonstration. This will allow the participants to see for themselves the different options that can easily be made using locally available materials. At the end of the activity, participants should visit each site to see the various tippy taps.

4.3.3 Module II Session 3: Improving Pig Management and Welfare

Time: 4 hours

Objectives of Session 3:

1. Describe different types of a pig pen
2. Identify locally available materials for the construction of pig pen
3. Prepare pig feed from locally available ingredients

Training resources

- Training manual Session 3.3.3
- **Toolkits** 10 – 14

A: Pig welfare

Explain to participants that, confinement of pigs is the best option to control TSCT and other diseases. However, confinement should go hand in hand with consideration of pig welfare since in the confinement pigs have no much freedom, hence choice. Therefore, adherence to the five freedoms of welfare is necessary: (1) Freedom from thirst and hunger - by providing access to fresh water and adequate feed to maintain full health and vigour, (2) Freedom from discomfort - by providing an appropriate environment including shelter and a comfortable resting area, (3) Freedom from pain, injury, and disease - by monitoring pig health and institute appropriate interventions should the pigs be found ill., (4) Freedom to express normal behaviour - by providing sufficient space, proper facilities and appropriate companion as necessary, and (5) Freedom from fear and distress - by providing appropriate conditions and treatments to the pigs.

B: Pig pen (120 minutes)

A pig pen can be constructed cheaply by using locally available materials. It needs to be constructed according to climatic conditions and according to the available building materials system (**Toolkit** 10 - 11).

- The pig pen should be comfortable for the pigs: good ventilation and ample shade, no overheating, no smells, no draft, and no dampness.
- The pig pen should be constructed with its long axis in an East-West direction (protected from sun and rain).
- The costs of constructing the pig pen should be affordable; hence the use of locally available materials is highly encouraged. Nevertheless, the design and material for pig pen construction should allow easy cleaning of the pen.

C: Pig Feeding (120 minutes)

Traditional pig feeds

Feeds should meet the animal's needs for maintenance, growth, and reproduction. The nutritional needs of pigs can be divided into six categories or classes. These are water, carbohydrates, fats, proteins, vitamins, and minerals. Rice bran, broken rice, maize, soya-beans, cassava, vegetables, and distillers' residues are often used in pig feed. You can use less expensive and locally available feeds, but can be nutritionally complete when properly prepared (**Toolkit: 12**). In fact, pigs can be fed well, using only kitchen scraps from a family's household.

Distillery waste is much appreciated in traditional pig husbandry, especially for fattening pigs. It is advisable, however, not to give this high-valued feed to pregnant and lactating sows and piglets and weaners because of the alcohol contents in the waste.

Feeding Alcohol Distilling Residues



Distillery Residues 5-10ltrs



Rice/Wheat Bran-1kg



Broken Rice/Maize grids-1kg mixed

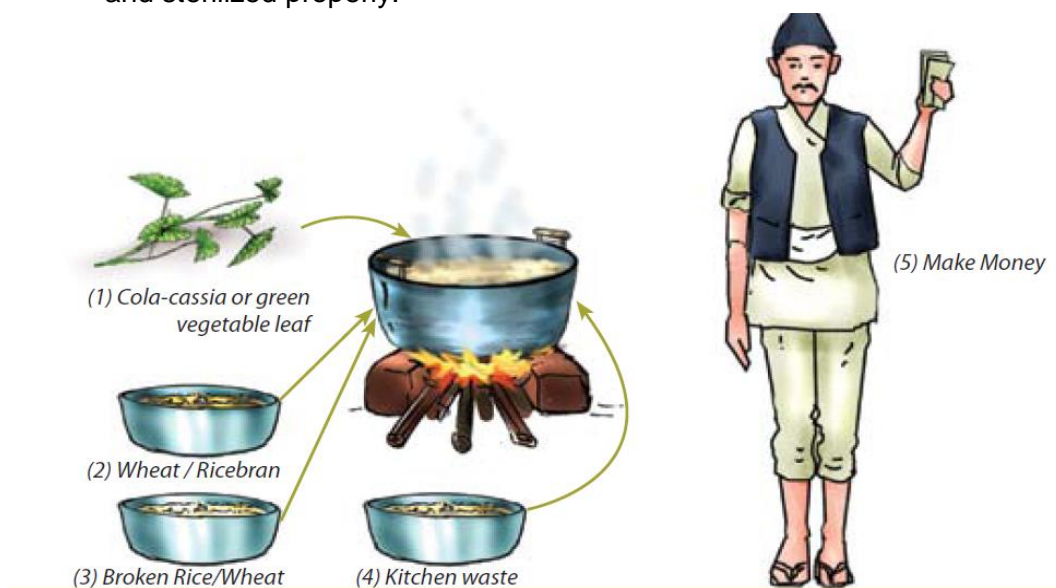
Source: (FAO, 2009)

Traditional feed processing

Different feeds are mixed and boiled to make the pig feed more palatable.

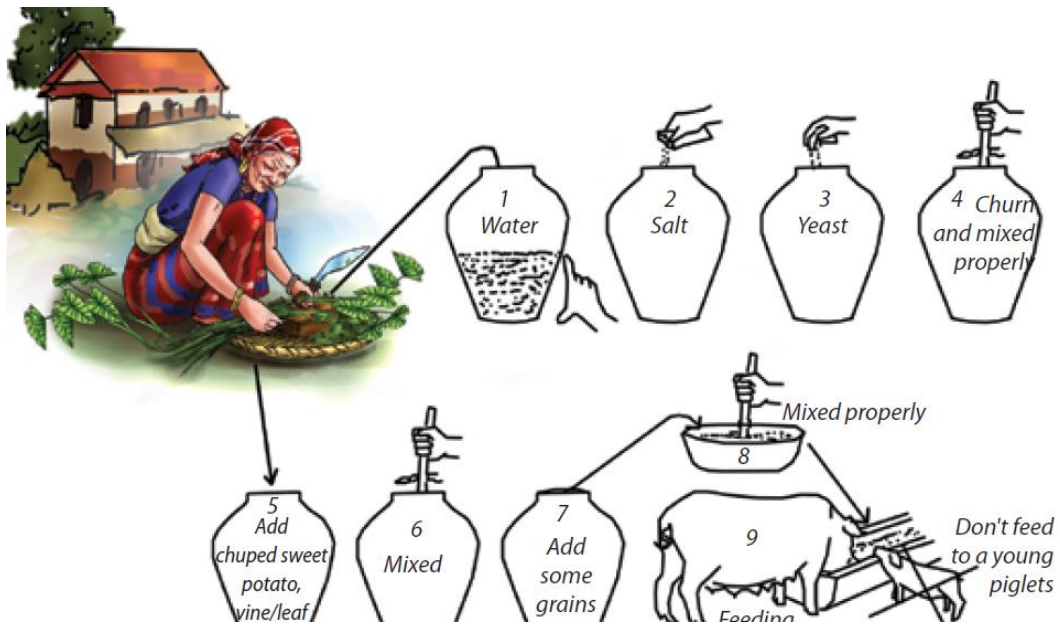
There are two types of traditional processing:

- Mix all different feeds (rice bran, broken rice, crushed maize and soya, dried legume leaves, etc) in proportion and give it directly to the pigs.
- Cooking the different raw materials together to improve digestibility and to break- down toxins from some feeds such as raw cola-cassia, banana stem, maize and soya grains, beans, kitchen waste, forage crops, etc.
- Food Waste Feeding to Swine is also commonly known as Garbage Feeding or Swill. Food waste or garbage fed to swine must be cooked and sterilized properly.



Feeding Forest Products

Pig feed can also be prepared with forest products (wild vegetables, wild bananas, wild cola – cassia, etc). At the same time, food waste can be used (kitchen, restaurant, fruits, soup, rice, noodles, etc). Growing legumes as feed for village pig production is having a big impact on the livelihoods of rural families. Below is an example of a locally prepared supplementary pig feed from forest products.



Feeding Alcohol distilling residues

Distillery wastes should be mixed with other feeds such as rice bran and broken rice/maize grids. Distillers' residues can be fed to fattening pigs, but not to pregnant or lactating sows. The following mixing ratio is commonly used in combination with distillery waste; Rice bran/Wheat bran (2 kg), broken rice (1 kg), Distillers' residues (5-10 kg), and other locally available agricultural by-products.

What you cannot feed to your pig

- Any carcass or part of a carcass of any mammal or bird (raw and uncooked); includes any meat blood, offal, hide, or feathers. Pigs that feed on carcass are also at risk of contracting diseases which is contagious to humans.
- Any fish products and bones.
- The excreta (droppings) of any mammal or bird
- Any substance that has come into contact with a prohibited substance via collection, storage, or transport in a contaminated container such as meat trays and take-away food containers.
- Household, commercial or industrial waste includes restaurant waste, without proper cooking and screening.

GROUP ACTIVITY

1. Divide the participants into four or five subgroups and have each group prepare pig feed from locally available ingredients
2. Provide each group with materials to make the pig feed
3. Hand out the **Toolkit 14** and/or explain carefully to the groups how to formulate pig feeds from their locally available ingredients.

4. Let each group formulate pig feed. The facilitator/animal scientist should also make one for demonstration. This will allow the participants to see for themselves the steps and different options that can easily help them using locally available materials. At the end of the activity, participants should visit each site to see the pig feeds.

4.4 Module II Evaluation (15 minutes)

Ask the participants to fill in the evaluation form provided (**Toolkit 23**). They should only evaluate Module II of the training with this form and only after completion of Module II training.

TRAINERS NOTE

Collect the completed evaluation forms and carry out analysis of the participants responses. Where possible, give feedback. Include this analysis in your training workshop report. !

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APPENDICES**Appendix 5: Toolkits to guide implementation of various activities during Module I and Module II training of trainers and local communities**

Toolkit 1: Lifecycle of *Taenia solium*

Toolkit 2: Faecal-oral routes

Toolkit 3: Procedure for washing hands correctly

Toolkit 4: Critical times to wash hands

Toolkit 5a: How to make a tilting jerry can tippy tap

Toolkit 5b: How to make other types of tippy taps

Toolkit 6: Water safety chain

Toolkit 7: Small doable actions (SDA) for WASH

Toolkit 8: Taking care of drinking and cooking water

Toolkit 9: Cleaning water storage containers

Toolkit 10: Different models of a pig pen

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Toolkit 17: Pig slaughter slab example

Toolkit 18: Evaluation questionnaire for Module I

Toolkit 19: How to boil and store water for drinking

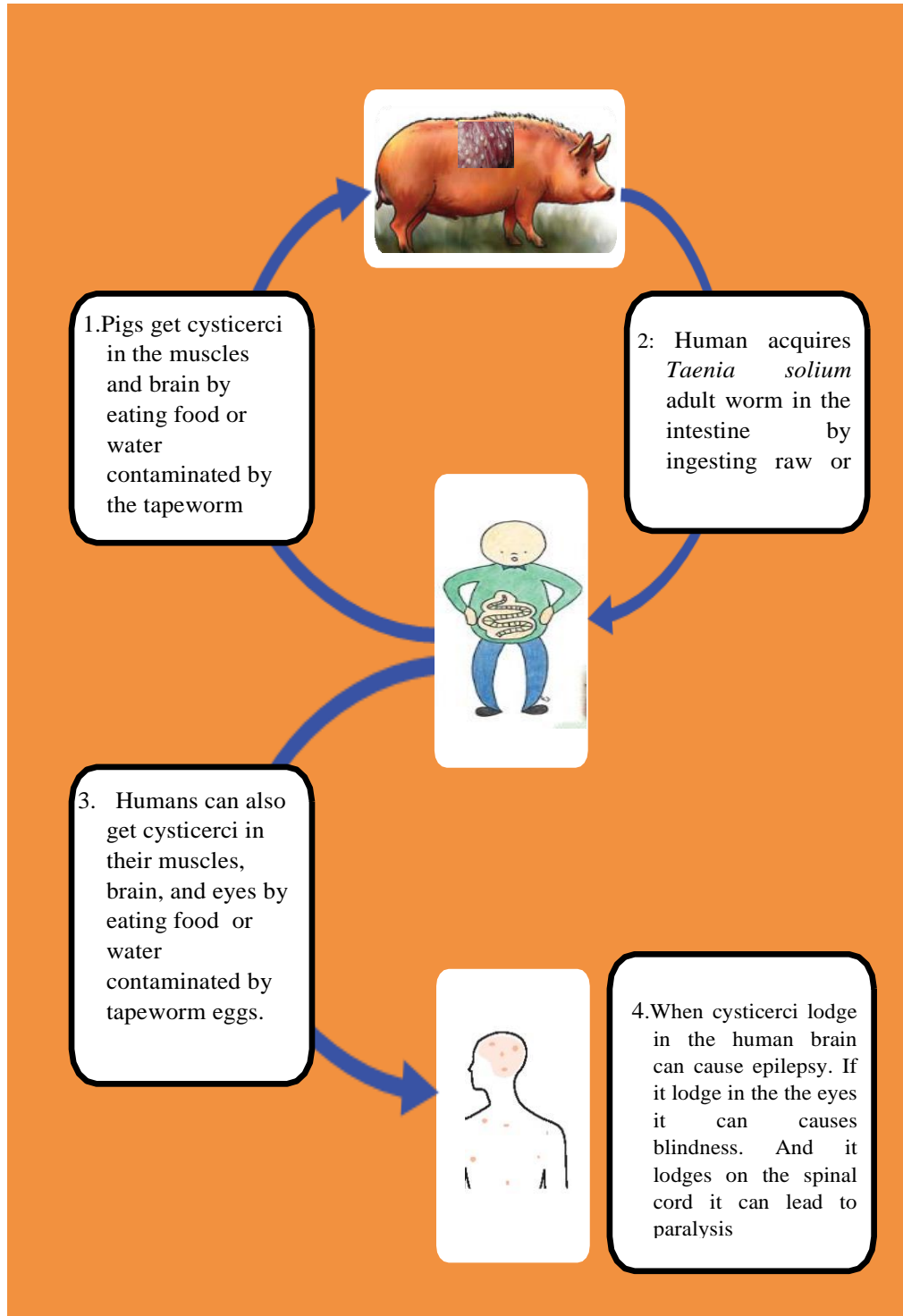
Toolkit 20: How to sanitize water for drinking using solar energy

Toolkit 21: How to sanitize water for drinking using liquid chlorine

Toolkit 22: How to sanitize water for drinking using chlorine in tablet form

Toolkit 23: Evaluation questionnaire for Module II

Toolkit 1: Lifecycle of *Taenia solium*



Toolkit 2: Faecal-oral routes



Source: (USAID/WASHplus Project 2014)

Toolkit 3: Procedure for washing hands correctly

1

Wet your hands with free flowing water and lather them with soap (or ash)



Rub your hands together and clean under your nails

2



3

Rinse your hands with a free flowing water



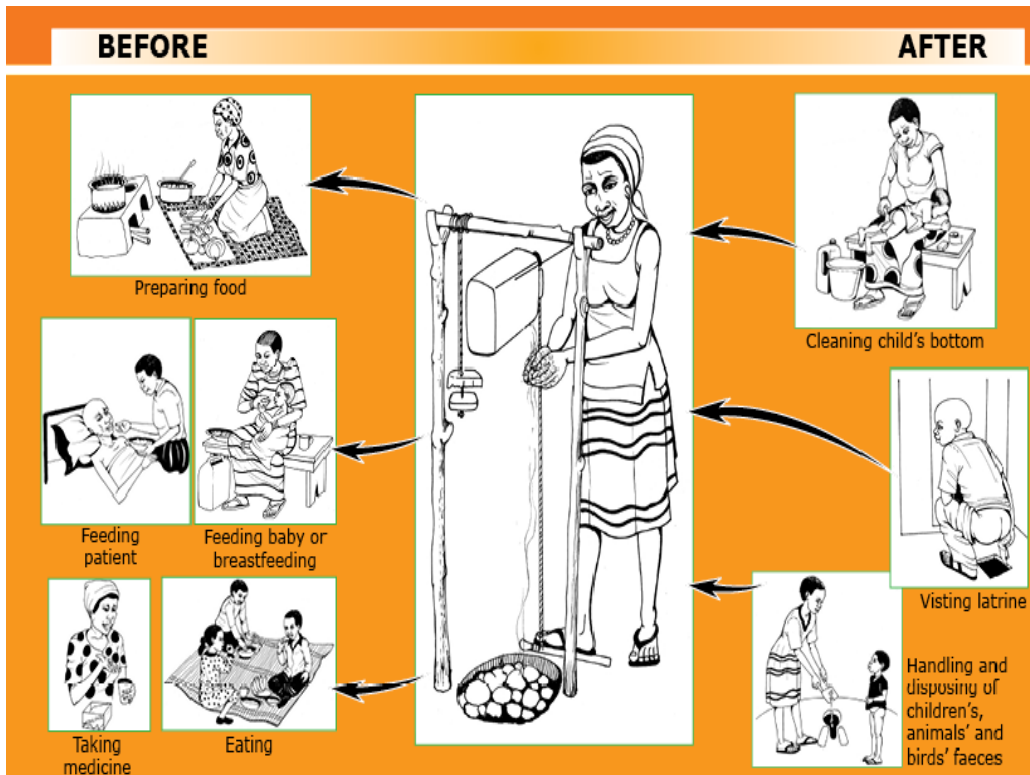
4



Shake excess water off your hands and air dry them

Source: (USAID/WASHplus Project 2014)

Toolkit 4: Critical times to wash hands



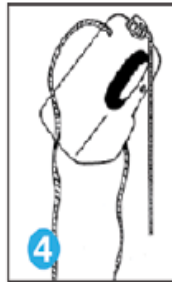
Source: (USAID/WASHplus Project 2014)

Toolkit 5a: How to make a tilting jerry can tippy tap

Materials needed: A small jerry can with a lid (3-5 litres). 2 pieces of heavy string (60 cm) for hanging jerry can and (100 cm) for the pedestal. A thin string (60 cm) for hanging soap. Three poles, 1 suspension pole (80 cm), two standing poles preferably "Y" (150 cm). A mineral water bottle for soap protection.



Get a clean jerry can



Place the hanging string through the nail holes and another string around the lid to attach to the pedestal



Using a nail, punch a hole on the lid for the pedestal string and at the jerry can handle for the dripping water.



Tie the solid stick to string attached to lid, long enough to reach about 10-13 cm from the ground. Step on the pedestal to tip water.

Put in place a soap pit by digging a shallow hole (60 cm wide and 30 cm deep)



Punch a hole for hanging string through the other side of the jerry can.

Hang the jerry can on two fixed poles. Make a hole in soap and cut the bottom off a mineral water bottle to use as a soap protector. Fix a string on them and hang on pole.

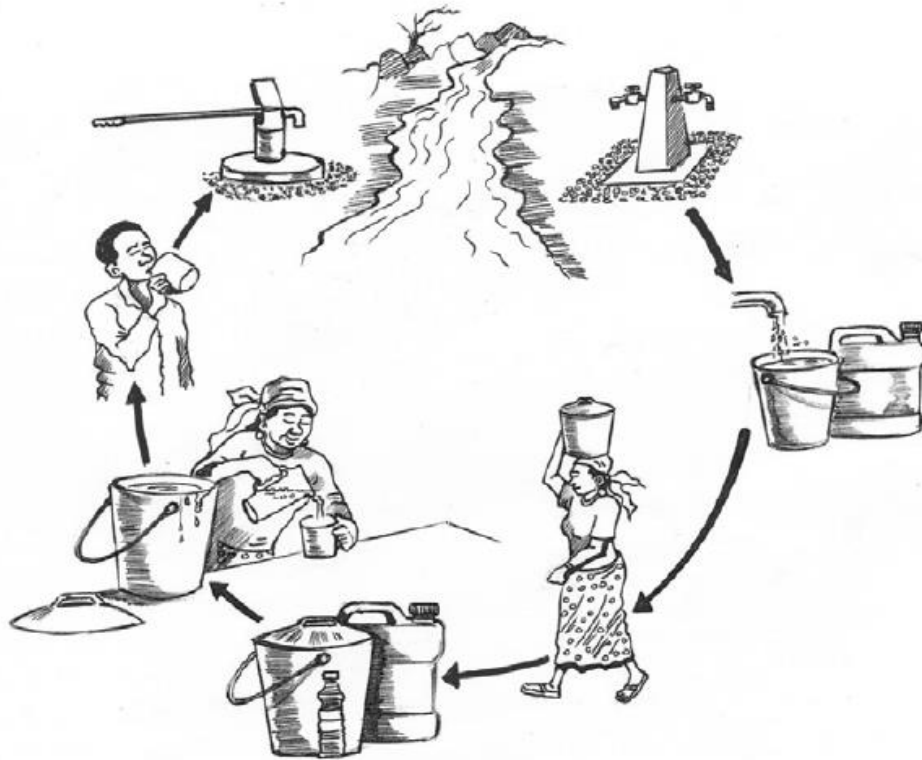
Source: (USAID/WASHplus Project 2014)

Toolkit 5b: How to make other types of tippy taps

<p>Punch a few holes on the mineral water bottle lid and one on the bottle to allow IN air</p>	<p>Fix poles.</p>	<p>Hang bottle and washing soap on the fixed poles. Pour water in the bottle</p>	<p>Use your elbow to tip the bottle facing down to allow water to flow</p>
<p>Make a hole at the bottom of the mineral water bottle</p>	<p>Fix string for hanging at the neck of the bottle</p>	<p>Hang bottle and washing soap on the fixed poles. Pour water in the</p>	<p>Loosen lid to allow water flow and tighten lid to stop water flow.</p>

Source: (USAID/WASHplus Project 2014)

Toolkit 6: Water safety chain



Source: (USAID/WASHplus Project 2014)

Steps in the water safety chain

Steps in the Water Safety Chain	Small Doable Actions to Keep Water Safe
Supply of Water	Protect the source: If a well or standpipe <ul style="list-style-type: none"> • Build a fence so animals cannot defecate nearby • Build a raised platform and/or a soak pit • Wash hands with soap before collecting water • Do not put hand into container when collecting If an open source stream: <ul style="list-style-type: none"> • Assure no animals or humans defecate upstream
Transporting Water	<ul style="list-style-type: none"> • Use a narrow neck container • Cover container • Attach cover to jerry can with a string so it doesn't get lost/stolen. Punch small hole in center of top. Thread with string and knot. Tie other end of string to neck of container, short enough so top doesn't touch the ground • Make a top with a clean potato or other object that can be washed • Do not stick hand into container when carrying
Storing Water	<ul style="list-style-type: none"> • Maintain water in narrow neck, covered container • Raise container off floor
Serving Water	If no spigot on container: <ul style="list-style-type: none"> • Pour water for use • Make a simple dipper/ladle for serving from calabash or can and stick. Hang on wall <ul style="list-style-type: none"> • Use mug with a handle to serve. Do not have hand touch water. Store in dedicated, clean place

Source: (USAID/WASHplus Project 2014)

Toolkit 7: Small doable actions (SDA) for WASH

PROBLEM	SMALL DOABLE ACTIONS
Latrines and Faeces Disposal	
<ul style="list-style-type: none"> • No resources to build a latrine 	<ul style="list-style-type: none"> • Devise small tool to be used for burying faeces and store in convenient place • Store tool in convenient place
Latrine privacy <ul style="list-style-type: none"> • Has no door • Straw wall has gaps • Latrine doors are hanging/ broken hinges 	<ul style="list-style-type: none"> • Hang a cloth as curtain • Patch the door so it's solid, or replace with other temporary material like chitenge or other material • Fix it! Often it will just take a few nails, screws, etc. for simple fixes
<ul style="list-style-type: none"> • Latrine smells • Flies in latrine 	<ul style="list-style-type: none"> • Look for options to increase ventilation without losing privacy • Cover pit with "home fashioned" lid • Put bucket of ash in latrine and have users throw a handful in after every use • Ash on hands is a good hand washing agent for after defecation
<ul style="list-style-type: none"> • No separate latrines for girls • No girl-friendly latrines 	<ul style="list-style-type: none"> • Clearly dedicate at least half of latrines for girls • Make signs "Girls Only" and "Boys Only" to mark • Add a private washing station and a little mirror if possible
Hand Washing	
<ul style="list-style-type: none"> • No fixed hand washing facility 	<ul style="list-style-type: none"> • Hang tippy tap outside of latrine
<ul style="list-style-type: none"> • No soap 	<ul style="list-style-type: none"> • Use ash
<ul style="list-style-type: none"> • No easy access to water 	<ul style="list-style-type: none"> • Make a tippy tap to minimize amount of water used in hand washing
Water Safety & Storage	
<ul style="list-style-type: none"> • Water stored in open container without lid 	<ul style="list-style-type: none"> • Change to closed container with cap • Tie lid to jerry can • Devise a convenient cover for bucket or container • (plastic bowl or clean potato)
<ul style="list-style-type: none"> • Dirty cups used to get water out of storage container 	<ul style="list-style-type: none"> • Make a dipper for extracting water from bucket or other receptacle • Hang dipper off ground
<ul style="list-style-type: none"> • Water from unprotected spring, shallow well, or other unsafe source 	<ul style="list-style-type: none"> • Filter water to remove dirt and then treat water by boiling, solar disinfecting or chlorinating

	<ul style="list-style-type: none"> • Build simple protection around spring
Food Safety & Handling	
<ul style="list-style-type: none"> • No handwashing facility near cooking/eating area 	<ul style="list-style-type: none"> • Hang tippy tap by cooking/eating area
<ul style="list-style-type: none"> • Food stored in open containers • Flies near stored food 	<ul style="list-style-type: none"> • Devise simple covers for food storage
<ul style="list-style-type: none"> • No dedicated food preparation area • Food preparation area on the ground • Food preparation area not washed daily 	<ul style="list-style-type: none"> • Create small, raised separate space for food preparation • Keep soap and water nearby to wash food preparation area daily
<ul style="list-style-type: none"> • Raw foods not cleaned before consumption 	<ul style="list-style-type: none"> • Ensure easy access to clean water to rinse fruits and vegetables eaten raw • Create a reminder of daily cleaning at appropriate spot, i.e. put a reminder near dish rack

Source: (USAID/WASHplus Project 2014)

Toolkit 8: Taking care of drinking and cooking water

1 Transport

Carry your water home in a container with a lid

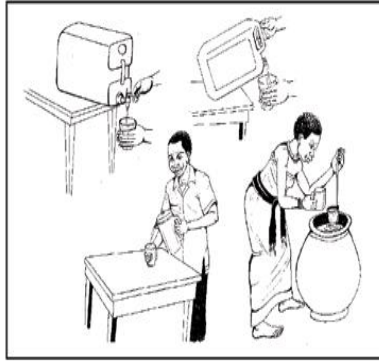


Small Doable Actions:

- Wash hands at source to avoid polluting new water
- Tie jerry can lid to container to avoid losing it
- Create a makeshift top with a clean potato washed each time at the source

2 Serving

Serve the water without letting anything dirty (such as your hands or a cup) touch it



Small Doable Actions:

- Raise the container off the floor, ideally waist height for easier serving
- Buy or make a ladle for serving and hang ladle on a wall
- Have separate cups for serving and drinking

3 Storage

Store water in a container with a tight-fitting lid



Small Doable Actions:

- Store container off the floor, ideally waist height for easy serving, to prevent contact with children and animals



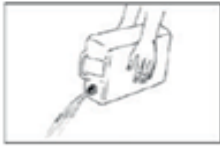



Source: (USAID/WASHplus Project 2014)

Toolkit 9: Cleaning water storage containers



Wash the containers using water, soap or ash. Small stones, sands or steel wire must not be used because they scratch the container leaving the breeding places for germs. Rugs, glass or any other material should not be used to clean drinking water containers, they can add germs that lead to contamination.

Washing water containers

 <p>1 Put small amount of soapy water or ash in the container, shake the container and pour out the water. Small stones, sands or steel wire must not be used because they scratch the container leaving the breeding places for germs.</p>		 <p>2 Rinse the containers with clean water until there is no dirt, soapy water or ash</p>
 <p>3 Use a rug to scrub the outside of the container with soap and water. Thereafter rinse them again with clean water</p>	 <p>4 Finally, hang the containers, preferably on a rack to allow them to dry</p>	 <p>5 Cover the containers tightly and keep them away from dirty</p>

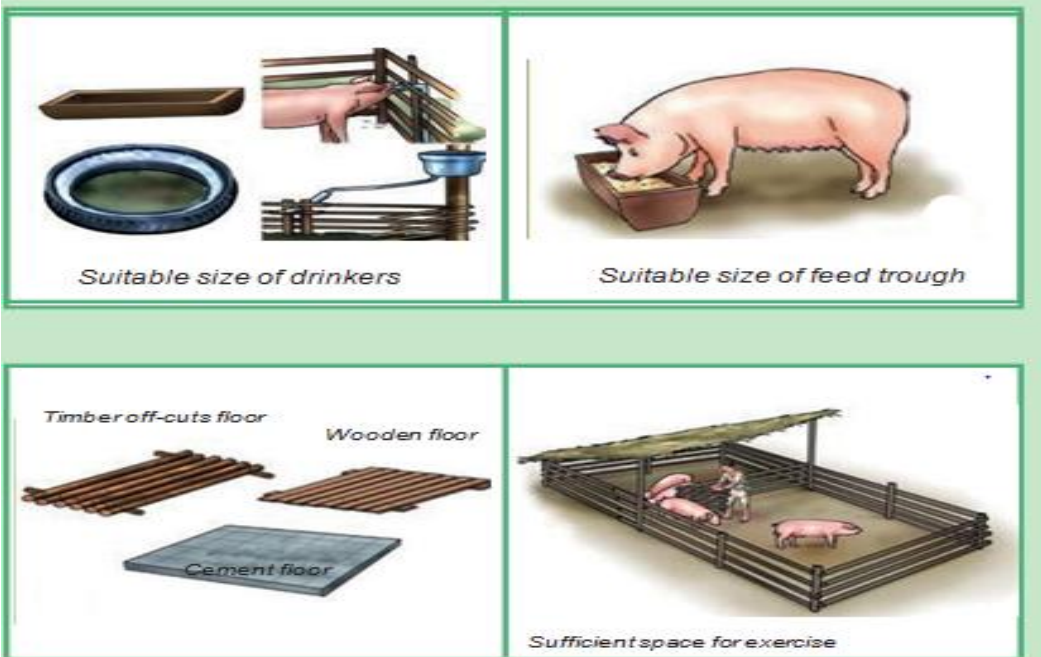
Source: (USAID/WASHplus Project 2014)

Toolkit 10: Different models of pig pen



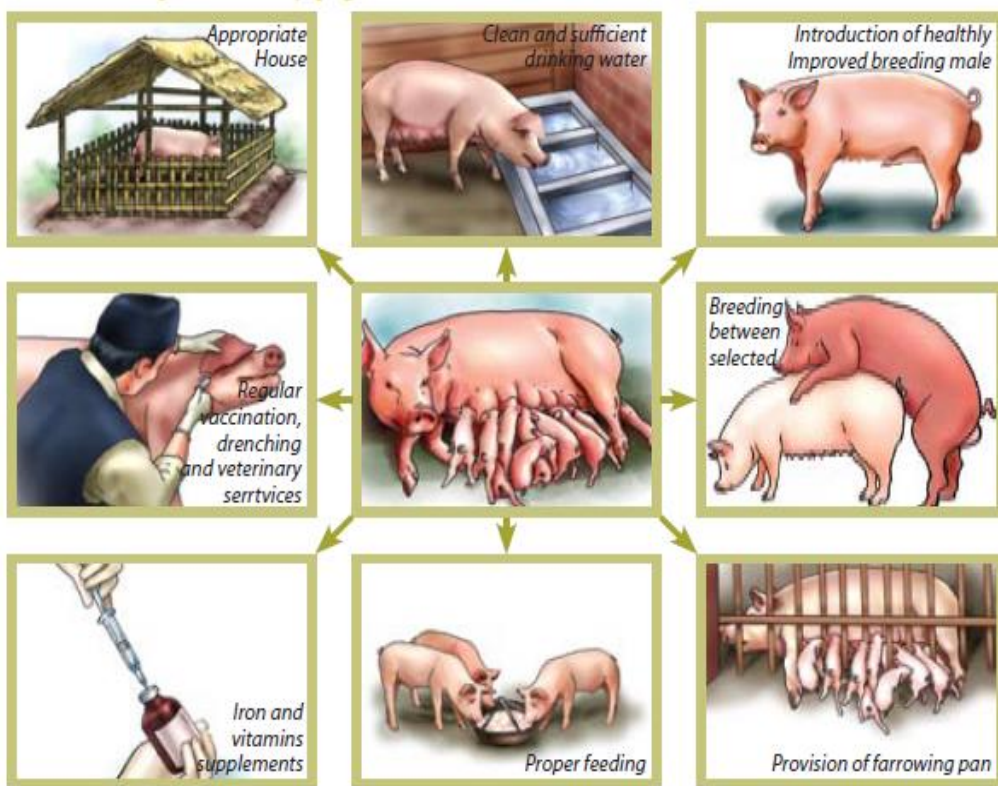
Source: (FAO, 2009)

Toolkit 11: Elements of a good pig housing



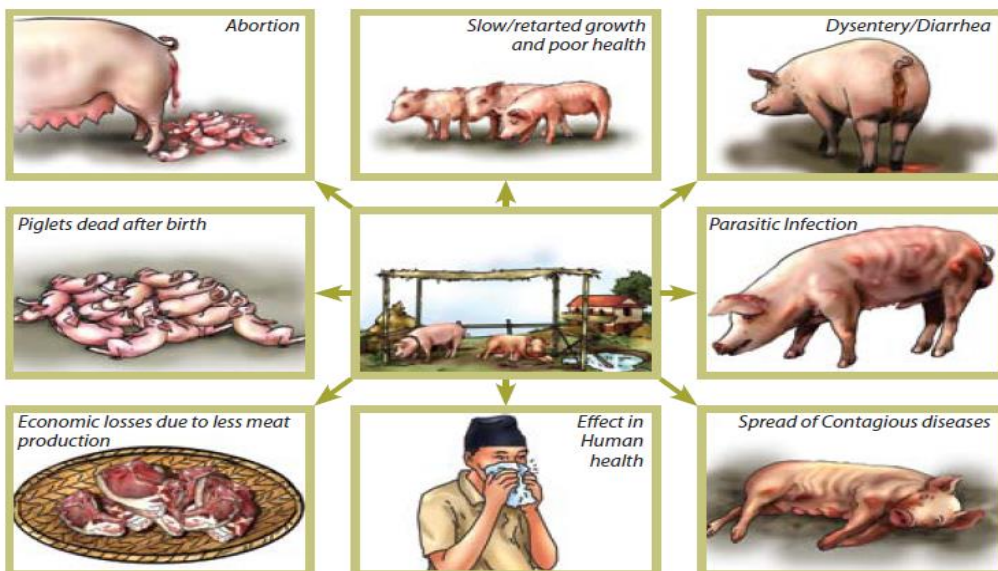
Source: (FAO, 2009)

Toolkit 12: How to keep pigs healthy










Source: (FAO, 2009)







Toolkit 13: Effects of bad pig housing



Source: (FAO, 2009)







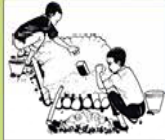




Toolkit 14: Locally available pig feeds

	Rice Bran: is very suitable for pig feeding. It contains 11% protein and can be used as the main ingredient. Rice bran can be mixed with other feeds to 30 - 45%. Rice bran can be kept no longer than 1 month because it can become mouldy.
	Broken Rice: is very suitable for pig feeding. It can be mixed with other feeds up to 15 - 20%. Broken rice contains about 8% protein.
	Maize: is a very good animal feed. It contains up to 65% carbohydrates and 9% protein. It can be mixed and cooked with other feeds, but not more than 40% in the mix ration. Wheat, millet and other cereals locally available can as well be used
	Soybeans and Green Soya bean plant: , is a crop which has a high nutritional value and is very good for pig feeding. It contains 38% protein (=very high). It should be dried, milled or well-cooked in combination with other feedstuff like rice bran, broken rice and maize.
	Leucaena and Acacia: are traditional, locally available tree-crops. The leaves are rich in protein. After drying, they can be mixed and fed to pigs with other feeds.
	Root Crops: are being used for pig feeding, they can be mixed with other feeds up to around 10 - 20% (never more than 30%). First it should be peeled and washed and then sliced, dried and ground before use. It should not be fed to pigs as raw cassava with the skin, because of toxic substances. The sliced and dried cassava can be kept longer.
	Fruits and vegetables: Fruits and vegetables damaged during transportation, storage and handling or from food waste are used as supplementary feeds for pigs by boiling and mixing with other feeds such as rice bran, broken rice and maize. They can also be given fresh. Suitable fruits are: Banana, papaya, apple, pear, melons etc. While suitable vegetables are; cabbage, lettuce, spinach, morning glory, sweet potato vine, cola-cassia (needs boiling), pumpkin, guards, water hyacinth etc

	<p>Restaurant/Kitchen waste: needs to be properly screening and cooking</p>
	<p>Slaughter house offal; needs to be properly screen and cooking</p>
	<p>Sweet potato/yam vine and tubers such as potato, yam, sweet potato, etc can be used as pig feed</p>
	<p>Banana Stem: The best way of feeding fresh green banana or plantain fruits is to chop them and sprinkle some salt on the slices since the fruits are very low in the in-organic nutrients. Cattle and pigs relish this material. For ensiling purposes, the chopped green bananas or plantains are preferred to the ripe fruits which lose some of their dry matter and, in particular sugars during ensiling. Similarly, green fruits are more easily dried than ripe fruits which are very difficult to completely dehydrate.</p>
	<p>Pumpkin: Pumpkin is a good source of the vitamin B group, while a large proportion of these vitamins is lost during the preparation of the protein concentrate and isolates.</p>
	<p>Alfalfa: Low in fibre, Palatable to consume for animal, easily digestible, it is the best nutritional package you can put into the rations feeding your livestock, dairy cattle, poultry or pig. Contains a blend of 47 nutritional elements one of nature's most liberal balances of vitamins, minerals and amino acids.</p>





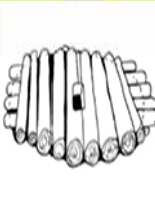






Source: (FAO, 2009)

Toolkit 15: How to build a traditional toilet in a stable soil

1. Dig pit				2. Masonry work	
					
Siting the latrine	Clear site	Measure site	Dig pit 0.6m wide, 0.9m long and 5m deep.	Create lining with stone or bricks Build 10 to 20 cm mud masonry work above the ground.	Put logs Put wood or logs on top of the pit and make sure that the wood or logs extend 50 cm beyond the edge of the pit.
<p>The pit should be dug:</p> <ul style="list-style-type: none"> • At least 10 metres away from kitchen or homestead • 30 metres from water sources • In the back of the dwelling house for privacy purposes 					
3. Make a pit cover, a squatting hole and superstructure			4. Prepare a latrine cover and hand washing station		
					
Put mud on the pit Cover the logs or wood with mud leaving squat hole of about 12.5 cm wide and 25 cm long.	If possible, install a SanPlat to make the latrine easy to clean and look modern.	Superstructure Then construct a superstructure and a roof with locally made materials and plaster the wall with mud or cow dung.	Make latrine cover Cut a piece of timber of 17 cm wide and 30 cm long and in its centre, fix a stick of about 50 cm long with a nail to make a squat hole cover.	Make a tippy tap Hang the tippy tap on the wall or poles or tree outside.	

Source: (USAID/WASHplus Project 2014)

Toolkit 16: How to build a shallow but hygienic latrine in rocky and sandy soils

					
Identify site for the toilet.	Clear the site.	Demarcate the area for the pit.	Dig pit of about 1 metre or less deep.	Put wood or logs on top of the pit and make sure that the wood or logs extend 50 cm beyond the edge of the pit.	Cover the logs or wood with mud, leaving a squat hole of about 12.5x25 cm. If possible, install a SanPlat to make the latrine easy to clean and look modern.
<p>The pit should be dug:</p> <ul style="list-style-type: none"> • At least 10 metres away from kitchen or homestead • 30 metres from water sources • In the back of the dwelling house for privacy purposes 					
			Benefits of composted pit waste		
Construct temporary superstructure using bamboo.	Fix a hand washing facility with soap or ash. Pour ash in latrine weekly to reduce bad smell.	When the latrine is full, dig another pit nearby and transfer the superstructure and slab to the new pit. Cover the old pit with soil and plant a fruit tree into the full pit.			After one year (no less) the contents may be removed and the composted manure applied to a garden.
<p>Handling fresh pit waste is a health hazard. Do not remove the contents of a pit before one year.</p>					

Source: (USAID/WASHplus Project 2014)

Toolkit 17: Pig slaughter slab example

Pig slaughter house at Mkumbi village, Mbanga district (Photo: C. Mkono, 2019)

Toolkit 18: Evaluation questionnaire for Module I

To be administered immediately before and after Module I

1. What is *Taenia solium*?
 - a. Bacteria
 - b. Worm
 - c. Virus
2. How does a person gets *Taenia solium* infection in the intestine?
 - a. Eating pig faeces that have the *Taenia solium*
 - b. Eating human faeces that have the *Taenia solium*
 - c. Eating meat from a pig infected by *Taenia solium*
3. How does a pig gets *Taenia solium* infection?

- a. Eating pig faeces that have the *Taenia solium* or feeds contaminated by such faeces
 - b. Eating human faeces that have the *Taenia solium* or feeds contaminated by such faeces
 - c. Eating meat from any animal infected by *Taenia solium*
4. In order to safeguard public health, schools and other communities must implement WASH programme. What are the three components of WASH focused in this programme?
 - a.
 - b.
 - c.
 5. What are the basic steps for washing hands correctly?
 - a. Wash thoroughly with water and dry
 - b. Apply soap, wash thoroughly, rinse and use paper towels to dry your hands or let them dry in air
 - c. Apply soap, wash thoroughly and dry using a cloth towel
 6. What is the reason for drying your hands after washing them?
 - a. So that you don't drip water everywhere
 - b. Because germs and bacteria are more easily spread with wet hands
 - c. Your hands are slippery when wet, and you will not be able to hold kitchen utensils properly
 7. How can you tell if food has enough bacteria to cause illness to the consumer?
 - a. It will smell
 - b. You can't always tell as the food may appear normal
 - c. It will have a different colour
 8. What would you consider as three main components of a complete latrine/toilet enclosure?
 - a. Intact floor, intact roof and intact wall
 - b. Intact roof, intact wall and intact door
 - c. Intact wall, a closing door and intact roof
 9. What are the main symptoms of a person suffering neurocysticercosis caused by *Taenia solium*?
 - a. Recurring fever
 - b. Abdominal discomfort
 - c. Epileptic seizures
 10. What are some of important measures to prevent humans from acquiring *Taenia solium* cysticercosis in the villages?
 - a. Thorough cooking of meat
 - b. Boil water intended for drinking
 - c. Regular use of bed nets

Toolkit 19: How to boil and store water for drinking

Follow the following step-by-step guide. If the water contains visible dirt or dust, first filter the water with a clean white cloth before



Collect water from water



Pour water into a boiling container



Cover the water boiling



Boil the water until large bubbles appear



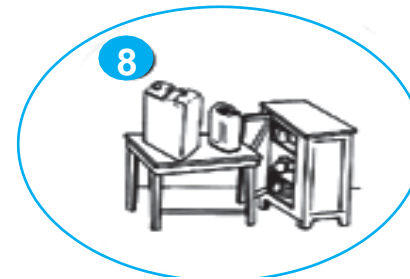
Remove from fire and allow to cool. Do not remove lid to avoid contamination container



Store boiled drinking water in containers with tight covers container cool. Do not remove lid to avoid contamination







Remove from fire and allow to cool.



Store drinking water in tightly covered containers, in a clean environment on a stool or table and away from children and animals cool. Do not remove lid to avoid contamination

Source: (USAID/WASHplus Project)

Toolkit 20: How to sanitize water for drinking using solar energy









1. Use clean, transparent plastic bottles that hold no more than 2.5 litres

2. Fill the bottles with clear water and screw the lid on tightly

3. Lay the bottles out in the sunlight. If it is sunny, leave the bottles for 6 hours

4. If it is cloudy, leave the bottles for 2 days

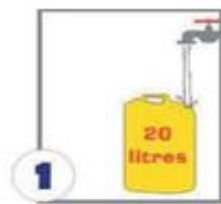
5. Before drinking the water, let it cool in the same bottle

6. Store the water in the same bottle. Do not change containers

7. DO NOT use SODIS when there is a continuous rain. Use another methods such as boiling or chlorination (WaterGuard)

Source: (USAID/WASHplus Project 2014)

Toolkit 21: How to sanitize water for drinking using liquid chlorine



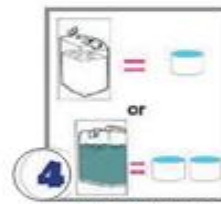
1
Filter a clean 20 litre jerry can with water filtered through a clean cotton cloth.



2
Fill the bottle cap with WaterGuard.



3
Pour the capful into the 20 litres of water.



4
For clear water use 1 capful. For dirty water use 2 capfuls.



5
Close the jerry can and shake.



6
Wait 30 minutes before using.



7
The water is now ready to drink.



8
Store it away from children and sunlight.

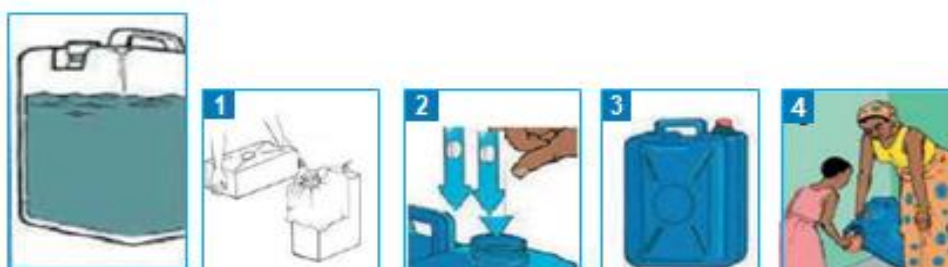
Remember: Water treated with WaterGuard that is stored in a narrow neck container with a tight fitting lid can be drunk for up to seven days. Treated water in a wide mouth container or without a tight fitting lid can be drunk for only 24 hours.

Source: (USAID/WASHplus Project 2014)

Toolkit 22: How to sanitize water for drinking using chlorine in tablet form



For clean water add 1 tablet in a 20 litre jerry can (filter the water through a clean cotton cloth if dirty). Wait 30 minutes before using.



If the water looks dirty, filter through a clean cotton cloth and add 2 tablet to 20 litres of filtered water. Wait 30 minutes before using.

Source: (USAID/WASHplus Project 2014)

Remember: Do not swallow tablets and store them away from children and sunlight. Water treated with WaterGuard that is stored in a narrow neck container with a tight fitting lid can be drunk for up to seven days. Treated water in a wide mouth container or without a tight fitting lid can be drunk for only 24 hours.

Toolkit 23: Evaluation questionnaire for Module II

1. Write two things that you learned today that you think will be useful in your work.

.....

2. Mentions things that were not clear to you even if an attempt to clarify them was made by the facilitate during the training workshop.

.....

3. Name things you would eliminate from the training that did not seem valuable, needed or “worth the time”.

.....
.....
.....

4. List things that you would have loved be added into this training that were not addressed

.....
.....

5. Give one sentence to summarize your overall experience during this training

.....
.....

2.2 Handbook (practical guide) with illustrations

HOW TO PREVENT AND CONTROL TAPEWORM (*TAENIA SOLIUM*) AFFECTING HUMAN BEINGS AND PIGS

A Practical Guide (booklet)

2021



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TANZANIA

1.0 INTRODUCTION

Pigs play a significant role, especially in small-scale enterprises where they contribute to securing the livelihoods of rural and urban communities. The pork tapeworm, *Taenia solium* has been an obstacle in pig production in many developing countries for many years, resulting in considerable economic and health burdens. This parasite is transmitted from a pig to a human through the consumption of infected pork, leading to an intestinal worm infection (taeniasis). *Taenia solium* can also be transmitted from a human to a pig or accidentally to a human through ingestion of feed or water contaminated with human faeces that may contain the microscopic *Taenia solium* eggs. Infection in this way is known as cysticercosis and occurs in tissues and the brain. Neurocysticercosis (NCC) manifested by epileptic seizures is the most dangerous form of *Taenia solium* infection in humans while cysticercosis in pigs results in considerable economic losses due to pork condemnation. Based on previous studies conducted in Tanzania, it is estimated that in 2012 Tanzania spent around 5 million USD to manage human epilepsy caused by *Taenia solium* and lost nearly 3 million USD due to condemnation of pork infected with *Taenia solium* (Trevisan *et al.*, 2017).

Prevalence and transmission of *Taenia solium* cysticercosis and taeniasis can largely be reduced and ultimately eliminated when local communities

are equipped with the necessary knowledge and tools to enable them to implement control measures. Most of these measures are basic but have a greater impact on the control of the diseases.

A comprehensive sociological study conducted in Tanzania in 2018 identified the following risk factors for TSCT: (i) Drinking unsafe water and poor personal hygiene, (ii) Absence or poor conditions of latrine/toilets, (iii) Limited use of latrine/toilets, (iv) Not washing hands with water and soap after visiting latrine and before eating, (v) Not washing fruit and vegetables before eating, (vi) Insufficient cooking of pork, (vii) Allowing pigs to roam, (viii) Home slaughter of pigs without professional meat inspection, (ix) Selling or consumption of infected pork/pigs, and (x) Not attending hospitals when sick.

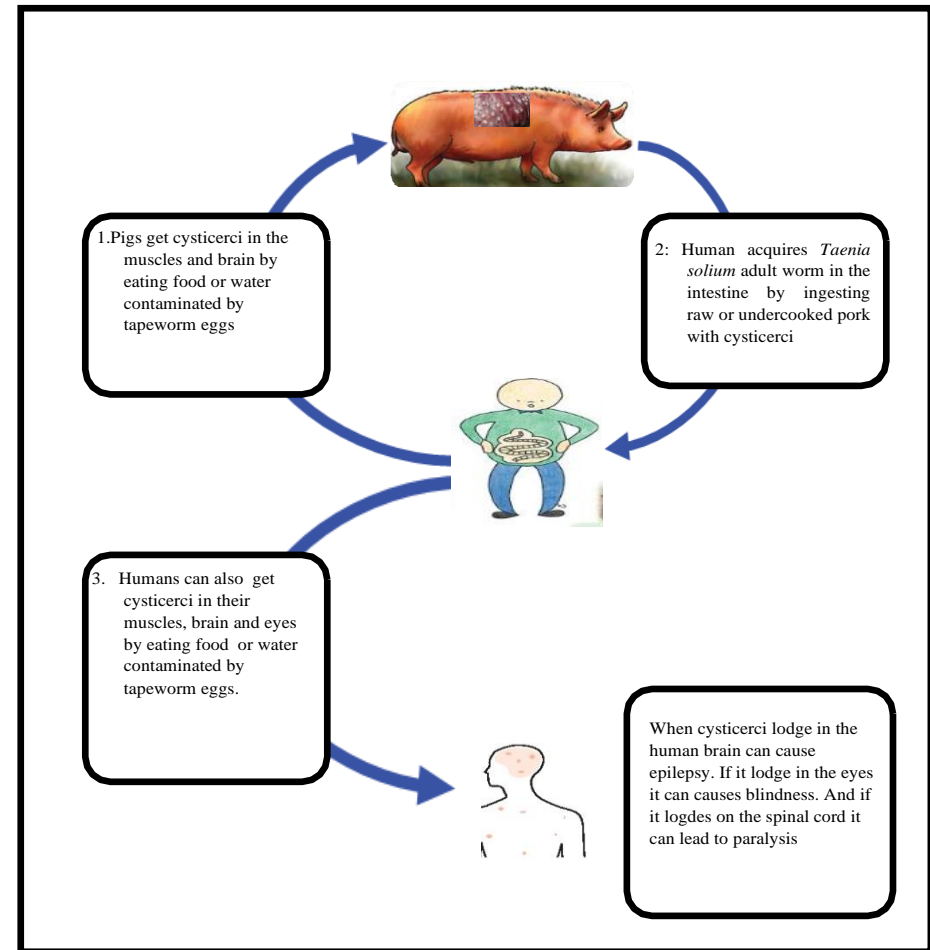
The obtained risk factors led to the development of several toolkits to guide local communities and households to implement Water, Sanitation, and Hygiene (WASH) as well as pig management measures for prevention and control of TSCT in their areas. This TSCT community implementation toolbox is targeted at local community trainers and households.

GUIDE

1

Understand the life cycle of tape worm (*Taenia solium*)

Taenia solium life cycle involves both humans and pigs. Read the following diagram from the first to the last step for more details.



GUIDE

2

Different types of toilets and importance of using and maintenance

There are three main types of latrines; (1) pit latrines, (2) ventilated improved pit latrines (VIPs) and (3) pour-flush latrines (URT, 2016). For schools and households in areas where no or insufficient water for flushing is available close to the latrine or where poor facilities are used for cleaning, the VIP latrine is the most suitable. If sufficient amount of water is available close to the latrine and the facilities are expected to be well maintained, a pour-flush latrine may be considered. Although these three latrine types are recommended, there is a range of options available for schools and households, and any latrine is better than no latrine.



a) Pit latrines



(b). Pour latrines



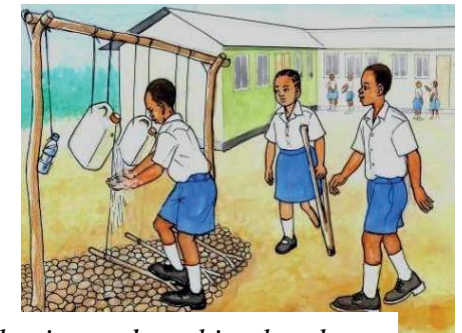
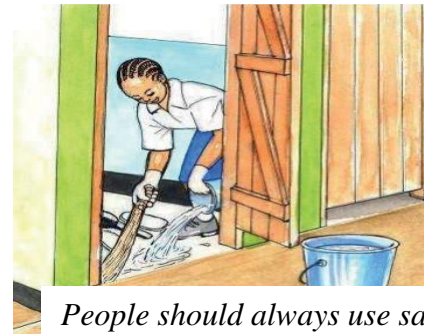
(c) Improved Pit Latrine for schools (no vent pipe)



(d) VIP latrines

The most important things to consider in any type of toilet are the following:

- The toilet should have solid walls, a roof and a door that should be closed
- The toilet should be cleaned regularly to keep it safe for the user
- The toilet should be used by everyone who needs the service. Avoid helping yourself in the field or in the bush
- It is important to wash your hands with clean running water and soap immediately after leaving the toilet



People should always use sanitary latrine and washing hands with soap after visiting latrines.

Source: URT (2016).

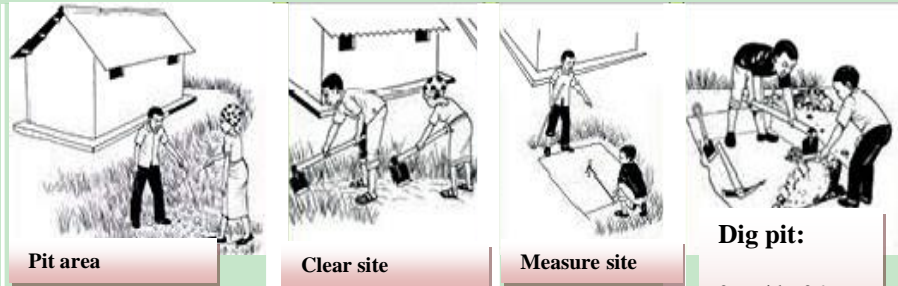
GUIDE

3

How to build a traditional toilet in a stable soil

Read the following diagram from the first to the last steps to learn how to build a traditional toilet in a stable soil

1. Dig pit



Dig pit:

0.6 wide, 0.9 long and 5m deep

The pit should be dug:

- At least 10 metres away from kitchen or homestead
- 30 metres from water sources
- In the back of the dwelling house for privacy purposes

2

Sitting the latrine

Masonry work



Create lining with stones or bricks:
Build 10 to 20 cm mud masonry work above the ground



Put wood or logs on top of the pit and make sure that the woods or logs extends 50 cm beyond the edge of the pit



3. Make a pit cover, a squatting hole and



Put mud on the pit: Cover the woods or log with mud, leaving a squatt hole of about 12.5 cm wide and to 25 cm long.



If possible install a Sanplat toile to make it easy to clean and look modern.



Superstructure: Then construct a superstructure with a roof using locally available materials and plaster the wall with mud or cowdung

4. Make a latrine cover and hand washing station



Make latrine cover: Cut a piece of timber of 17 cm wide and 30 cm long and in its centre fix a stick of about 50 cm long with a nail



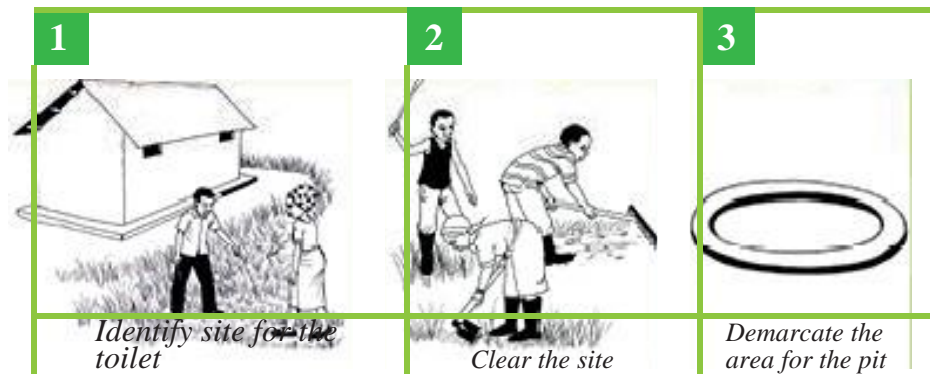
Make a tippy tap: Hang the tippy tap on the walls or poles or trees

Source: (USAID/WASHplus Project 2014)

GUIDE

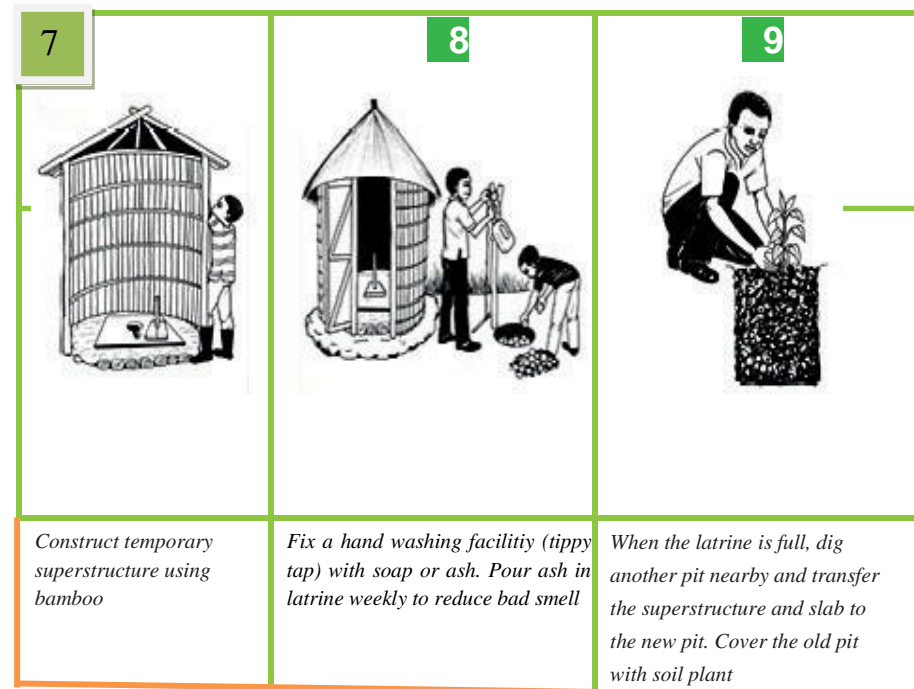
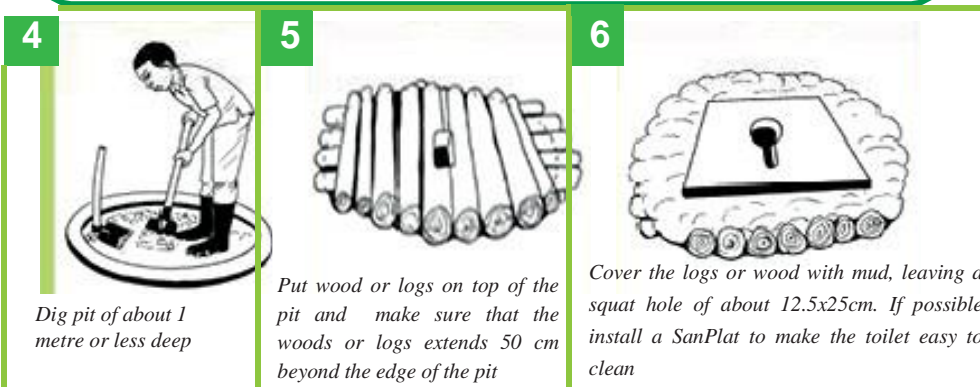
How to build a shallow but hygienic latrine in rocky and sandy soils

Read the following diagram from the first to the last steps to learn how to build a shallow toilet that is hygienic on rocky and sandy soils



The pit should be dug:

- At least 10 metres away from kitchen or homestead
- 30 metres from water sources
- In the back of the dwelling house for privacy purposes



Benefit of composted pit waste



After one year (no less), the content may be removed and the composted manure applied to a garden

Source: (USAID/WASH plus, 2014)

GUIDE

5

Procedure for washing hands

1

Wet your hands with free flowing water and lather them with soap (or ash)



2

Rub your hands together and clean under your nails



Rinse your hands with a free flowing water

3



4

Shake excess water off your hands and air dry

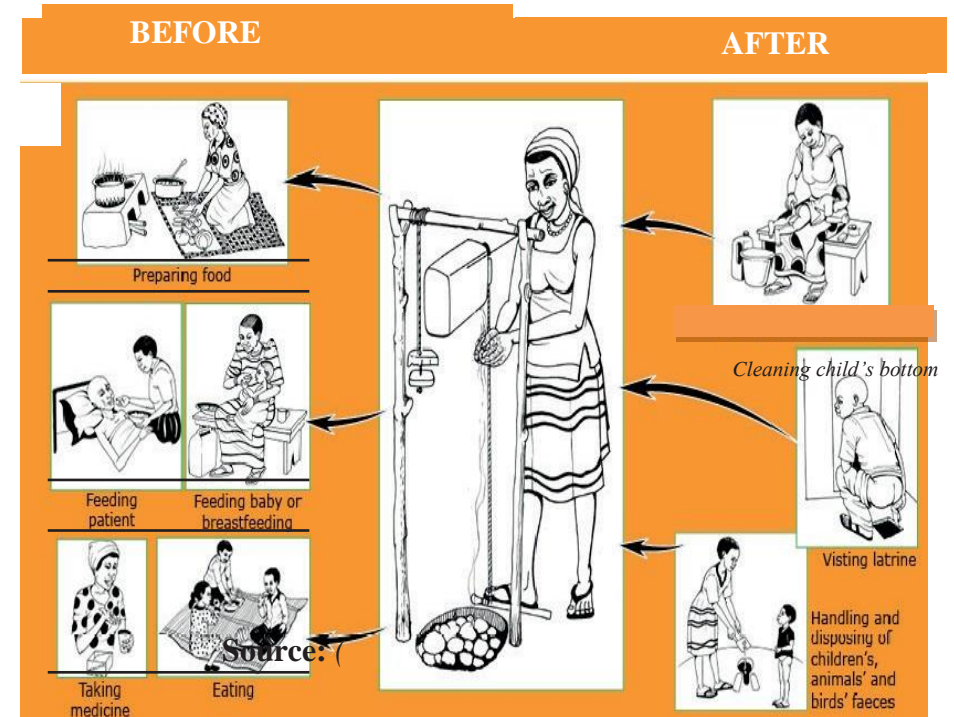


GUIDE

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Critical times to wash hands

Read the following diagram to find out the most important times you should wash your hands



Source: (USAID/WASHplus Project 2014)

Guide

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How to make a tilting jerry can tippy tap

Tippy tap is an important tool for accessing running water in an environment without piped water. There are several types of tippy taps, depending on the type of container. The tool can be made using a different tippy taps are plastic containers, plastic water bottles, plastic buckets and so on. Here we will see how to make a tippy tap with a plastic jar.

Materials needed:

- A small jerry can with a lid (3-5 litres)
- 2 pieces of heavy string (60 cm) for hanging jerry can and (100cm) for the pedestal.
 - A thin string (60 cm) for hanging soap.
 - Three poles, 1 suspension pole (80 cm), two standing poles preferably “Y” (150 cm).
 - A mineral water bottle for keeping soap.



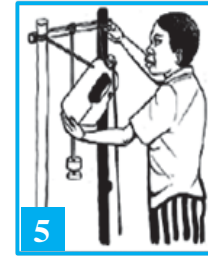
Get a clean jerry can



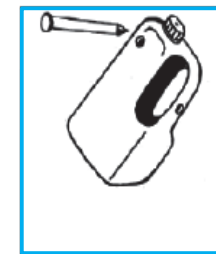
Place the hanging string through the nose and another string around the lid to attach the pedestal



Using a nail punch a hole on the lid For the pedestal string and at the jerry can handle for the dripping water



Hang the jerry on two fixed poles cut the bottom off a mineral water bottle to use as a soap protector. Fix a string on them and hang on pole



Punch a hole for hanging a string through the other side of a jerry can



Tie solid stick to string attached to lid, long enough to reach about 10-13 cm from the ground. Step on the pedestal to tip water. Put in place a soap pit by digging a shallow hole (60 cm wide and 30 cm deep)

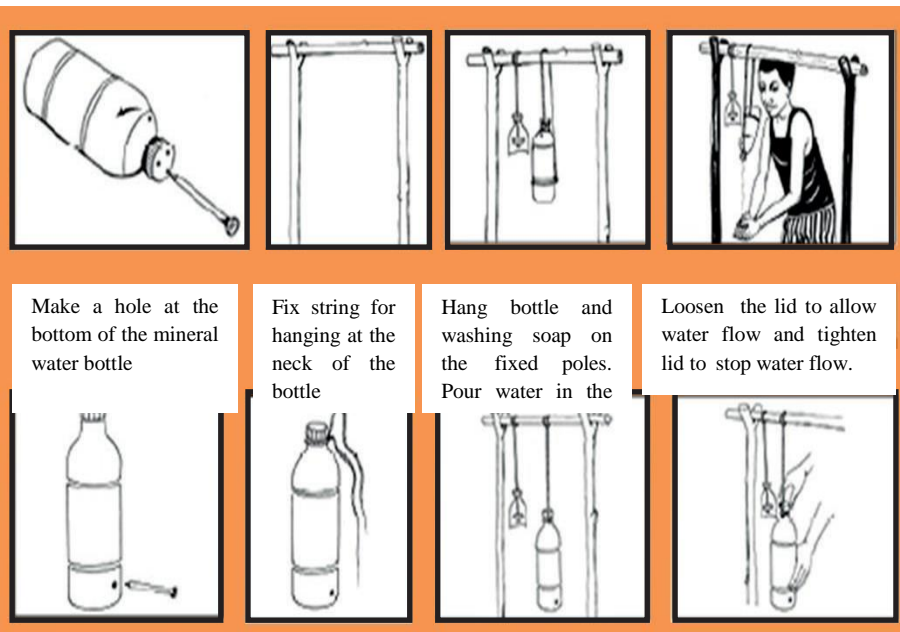
Source: (USAID/WASH plus, 2014)

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How to make other types of tippy taps

Follow the following example to understand how to make a bottle tippy tap



Make a hole at the bottom of the mineral water bottle



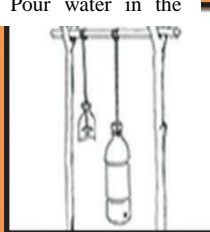
Punch a few holes on the mineral water bottle lid and one on the bottle to allow in air

Fix string for hanging at the neck of the bottle



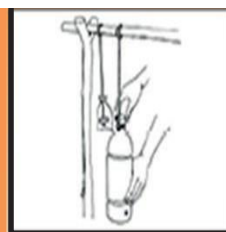
Fix poles.

Hang bottle and washing soap on the fixed poles. Pour water in the



Hang bottle and washing soap on the fixed poles. Pour water in the bottle

Loosen the lid to allow water flow and tighten lid to stop water flow.



Use your elbow to tip the bottle facing down to allow water to flow

Source: (USAID/WASHplus Project 2014)

GUIDE

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Water safety chain

The clean water system should be maintained based on the following factors;

- Water sources should be elevated to reduce the risk of contamination
- Water source should be fenced off to prevent humans and animals from contaminating water
- Other areas in the entire water system should be fully maintained
- Wash hands with clean water before fetching water anywhere in the water system
- Make sure the water pump is clean and safe



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Small doable actions (SDA) for WASH

PROBLEM	SMALL DOABLE ACTIONS		
Latrines and Faeces Disposal			
<ul style="list-style-type: none"> No resources to build a latrine 	<ul style="list-style-type: none"> Dig a shallow pit latrine with help of community led total sanitation Committee (CLTS) 		
Latrine privacy			
<ul style="list-style-type: none"> Has no door Straw wall has gaps Latrine doors are hanging/ broken hinges 	<ul style="list-style-type: none"> Hang a cloth as curtain Patch the door so it's solid Fix it! Often it will just take a few nails, screws, etc. for simple fixes 		
<ul style="list-style-type: none"> Latrine smells Flies in latrine 	<ul style="list-style-type: none"> Look for options to increase ventilation without losing privacy Cover pit with "home fashioned" lid Put bucket of ash in latrine and have users throw a handful in after every use (ash on hands is a good hand washing agent for after defecation) 		
<ul style="list-style-type: none"> No separate latrines for girls and boys No girl-friendly latrines 	<ul style="list-style-type: none"> Clearly dedicate at least half of latrines for girls Make signs "Girls Only" and "Boys Only" to mark Separate hand washing facilities based on gender and if possible add a mirror In a girls latrine. 		
Hand Washing			
<ul style="list-style-type: none"> No fixed hand washing facility 	<ul style="list-style-type: none"> Make and hang tippy tap outside of latrine 		
<ul style="list-style-type: none"> No soap 	<ul style="list-style-type: none"> Buy soap and place at a handwashing facility Make liquid soap Use ash if soap is not accessible 		
<ul style="list-style-type: none"> No easy access to water 	<ul style="list-style-type: none"> Make a tippy tap to minimize amount of water used in hand washing 		
		<ul style="list-style-type: none"> Water from unprotected spring, shallow well, or other unsafe source 	<ul style="list-style-type: none"> Filter water to remove dirt and then treat water by boiling, solar disinfecting or chlorinating
		Food Safety & Storage	
		<ul style="list-style-type: none"> No handwashing facility near cooking/eating area 	<ul style="list-style-type: none"> Hang tippy tap by cooking/eating area
		<ul style="list-style-type: none"> Food stored in open containers Flies near stored food 	<ul style="list-style-type: none"> Devise simple covers for food storage
		<ul style="list-style-type: none"> No dedicated food preparation area Food preparation area on the ground Food preparation area not washed daily 	<ul style="list-style-type: none"> Create small, raised separate space for food preparation Keep soap and water nearby to wash food preparation area daily
		<ul style="list-style-type: none"> Raw foods not cleaned before consumption 	<ul style="list-style-type: none"> Ensure easy access to clean water to rinse fruits and vegetables eaten raw

Water Safety and Storage	
<ul style="list-style-type: none"> Water stored in open container without lid 	<ul style="list-style-type: none"> Close container with cap Devise a convenient cover for bucket
<ul style="list-style-type: none"> Dirty cups used to get water out of storage container 	<ul style="list-style-type: none"> Make a dipper from a calabash or tin can and stick for extracting water from bucket or other receptacle Hang dipper off ground

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Taking care of drinking and cooking water



1. TRANSPORT

Carry your water home in a container with a lid



2. SERVING

Serve the water without letting anything dirty (such as your hands or a cup) touch it



3. STORAGE

Store water in a container with tight-fitting lid

Cleaning water storage containers



Wash the containers using water, soap or ash. Small stones, sands or steel wire must not be used because they scratch the container leaving the breeding places for germs. Rugs, glass or any other material should not be used to clean drinking water containers, they can add germs that lead to contamination.

Washing water containers



1

Put small amount of soapy water or ash in the container, shake the container and pour out the water. Small stones, sands or steel wire must not be used because they scratch the container leaving the breeding places for germs.



2. Rinse the containers with clean water until there is no dirt, soapy water or ash



3. Use a rug to scrub the outside of the container with soap and water. Thereafter rinse them again with clean water



4. Finally, hang the containers, preferably on a rack to allow them to dry



5. Cover the containers tightly and keep them away from dirty

Alternative water sources



Rainwater harvesting without gutters

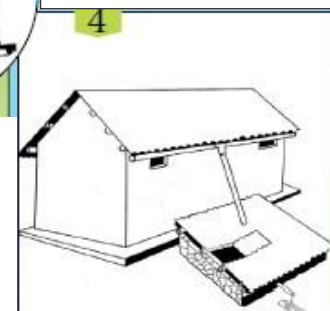


Rainwater harvesting without gutters



Rain water harvesting with a water jar

Cut out iron sheets to make gutters and delivery pipe. Use wires to mount gutters onto the roof



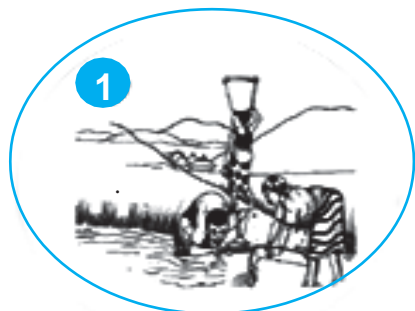
Rain water harvesting with a cistern

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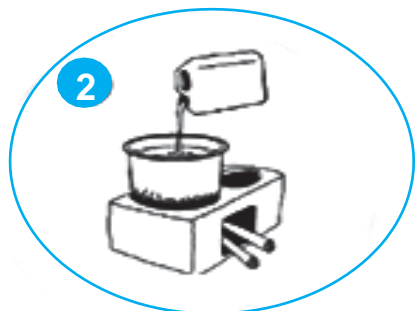
14

How to boil and store water for drinking

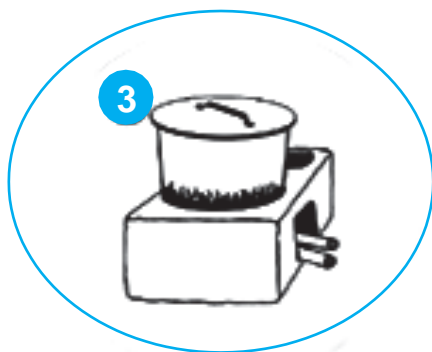
Follow the following step-by-step guide. If the water contains visible dirty or dust, first filter the water with a clean white cloth before proceeding with water treatment.



Collect water from water source



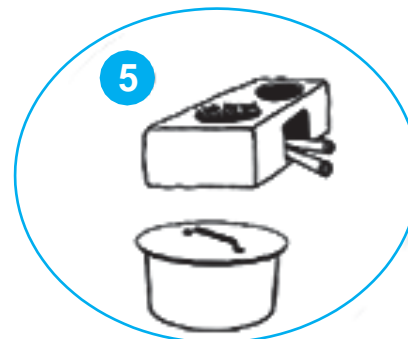
Pour water into boiling container.



Cover the water boiling container



Boil the water until large bubbles appear.



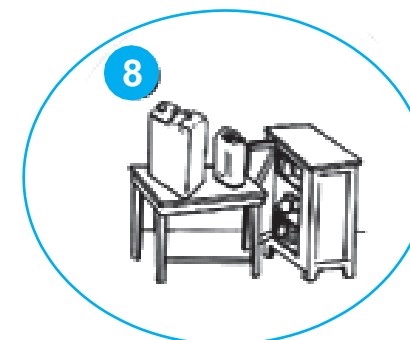
Remove from fire and allow to cool. Do not remove lid to avoid contamination



Store boiled drinking water in containers



Do not use the serving cup for drinking



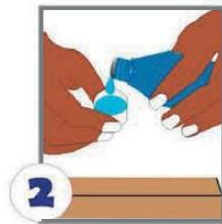
Store drinking water in tightly covered containers, in a clean environment on a stool or table and away from children and animals

Source: (USAID/WASH plus , 2014)

How to sanitize water for drinking using liquid chlorine (WaterGuard)



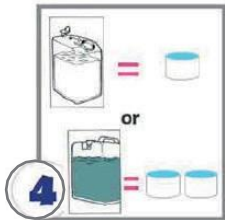
1 Filter a clean 20 litre jerry can with water filtered through a clean



2 Fill the bottle cap with WaterGuard.



3 Pour the capful into the 20 litres of water.



4 For clear water use 1 capful. For dirty water use 2 capfuls.



5 Close the jerry can and shake



6 Wait 30 minutes before using.

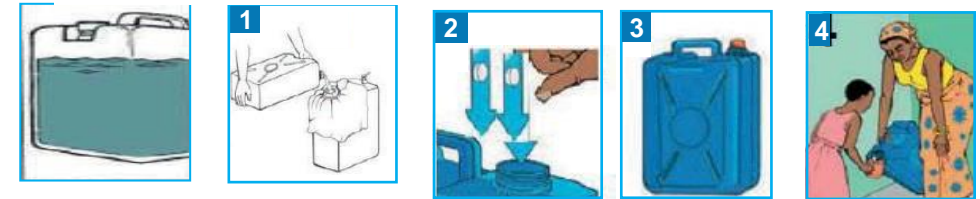


7 The water is now ready to drink

How to sanitize water for drinking using chlorine (WaterGuard) in tablet form



For clean water add 1 tablet in a 20 litre jerry can (filter the water through a clean cotton cloth if dirty). Wait 30 minutes before using.



If the water looks dirty, filter through a clean cotton cloth and add 2 tablet to 20 litres of filtered water. Wait 30 minutes before using.

Remember: Do not swallow tablets and store them away from children and sunlight. Water treated with WaterGuard that is stored in a narrow neck container with a tight fitting lid can be drunk for up to seven days. Treated water stored in a wide mouth container or without a tight fitting lid can be drunk for only 24 hours.

Source: (USAID/WASHplus Project 2014)

How to sanitize water for drinking using solar



1. Use clean, transparent plastic bottles that hold no more than 2.5 litres

2. Fill the bottles with clear water and screw the lid on tightly



3. Lay the bottles out in the sunlight. If it is sunny, leave the bottles for 6 hours

4. If it is cloudy, leave the bottles for 2 days



5. Before drinking the water, let it cool in the same bottle

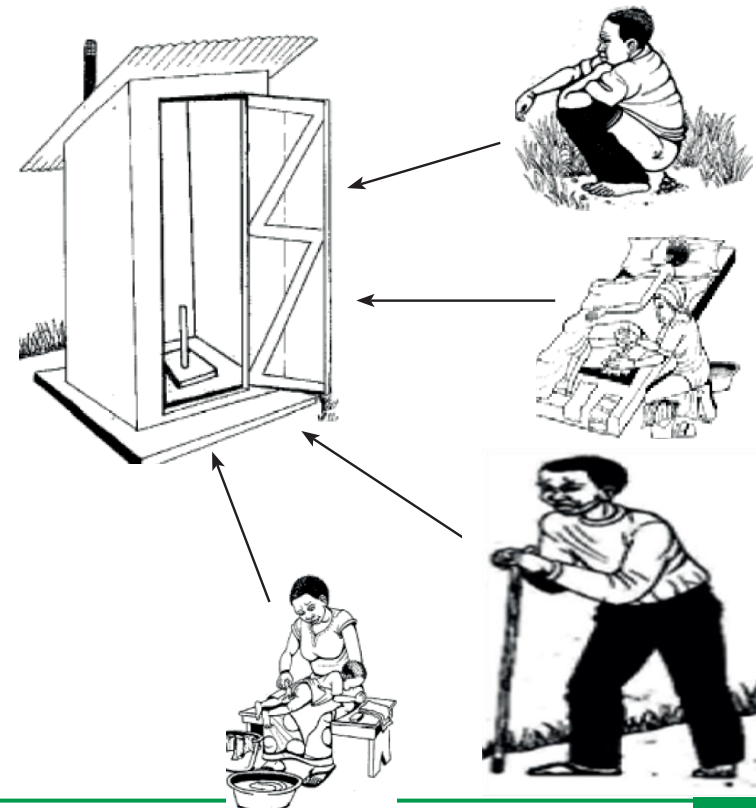
6. Store the water in the same bottle. Do not change containers



7. DO NOT use SODIS when there is a continuous rain. Use another methods such as boiling or chlorination (WaterGuard)

The correct way to dispose of human beings

Put faeces of sick people, adult, children, babies and other disabled people in a latrine.



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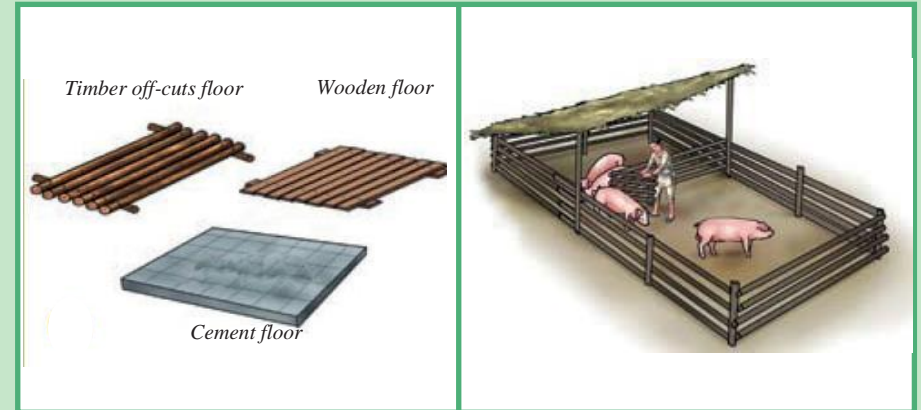
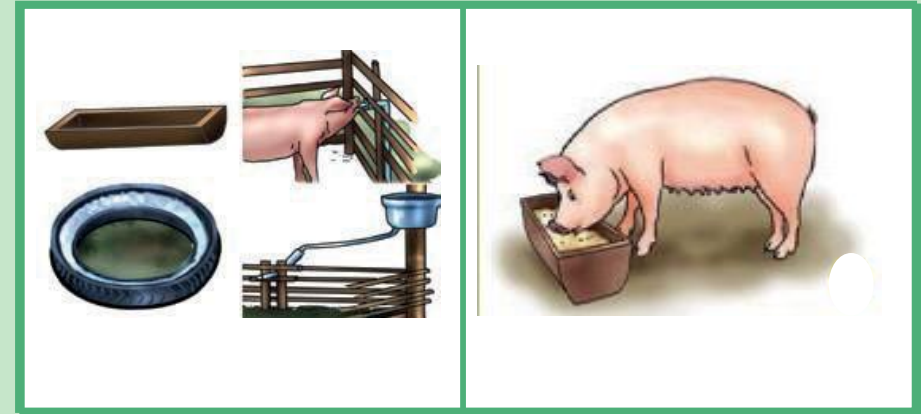
Different models of pig pen



Source: FAO, 2009

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Elements of a good housing






Source: FAO, 2009

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Locally available pig feeds

	<p>Rice Bran: is very suitable for pig feeding. It contains 11% protein and can be used as the main ingredient. Rice bran can be mixed with other feeds to 30 - 45%. Rice bran can be kept no longer than 1 month because it can become mouldy.</p>
	<p>Broken Rice: is very suitable for pig feeding. It can be mixed with other feeds up to 15 - 20%. Broken rice contains about 8% protein.</p>

	<p>Maize: is a very good animal feed. It contains up to 65% carbohydrates and 9% protein. It can be mixed and cooked with other feeds, but not more than 40% in the mix ration. Wheat, millet, and other cereals locally available can as well be used</p>
	<p>Soybeans and Green Soya bean plant: is a crop that has a high nutritional value and is very good for pig feeding. It contains 38% protein (=very high). It should be dried, milled, or well-cooked in combination with other feedstuff like rice bran, broken rice, and maize.</p>
	<p>Leucaena and Acacia: are traditional, locally available tree crops. The leaves are rich in protein. After drying, they can be mixed and fed to pigs with other feeds.</p>



Root Crops: are being used for pig feeding, they can be mixed with other feeds up to around 10 - 20% (never more than 30%). First, it should be peeled and washed and then sliced, dried, and ground before use. It should not be fed to pigs as raw cassava with the skin, because of toxic substances. The sliced and dried cassava can be kept longer.




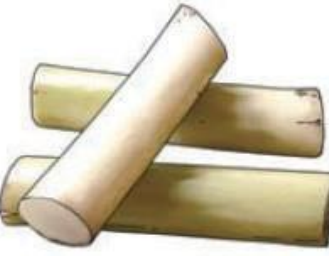
Fruits and vegetables: Fruits and vegetables damaged during transportation, storage, and handling or from food waste are used as supplementary feeds for pigs by boiling and mixing with other feeds such as rice bran, broken rice, and maize. They can also be given fresh. Suitable fruits are: Bananas, papaya, apple, watermelons, etc. While suitable vegetables are; cabbage, lettuce, spinach, morning glory, sweet potato vine, cola-cassia (needs boiling), pumpkin, guards, water hyacinth etc





Restaurant/Kitchen waste: needs to be properly screened and cooking



Slaughter house offal; needs to be properly screen and cooking

	<p>Sweet potato/yam vine and tubers such as potato, yam, sweet potato, etc can be used as pig feed</p>
	<p>Banana Stem: The best way of feeding fresh green banana or plantain fruits is to chop them and sprinkle some salt on the slices since the fruits are very low in inorganic nutrients. Cattle and pigs relish this material. For ensiling purposes, chopped green bananas or plantains are preferred to ripe fruits which lose some of their dry matter and, in particular sugars during ensiling. Similarly, green fruits are more easily dried than ripe fruits which are very difficult to completely dehydrate.</p>

	<p>Pumpkin: Pumpkin is a good source of the vitamin B group, while a large proportion of these vitamins is lost during the preparation of the protein concentrate and isolates.</p>
	<p>Alfalfa: Low in fiber, palatable to consume for the animal, and easily digestible, it is the best nutritional package you can put into the rations feeding your livestock, dairy cattle, poultry, or pig. Contains a blend of 47 nutritional elements one of nature's most liberal balances of vitamins, minerals, and amino acids.</p>

Source: (FAO, 2009)

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PIG SLAUGHTER HOUSE

This is a simple example of a pig slaughterhouse that can be used in villages. However, pig abattoirs should have basic requirements including:

- A strong fence to prevent uninvolved humans or animals from entering the abattoir and causing damage or spreading disease
- Clean water and sewage system to enable sanitation to be done smoothly and easily
- Waste disposal pit to destroy (burn) all wastes and condemned pork not suitable for human consumption
- Toilet for human use
- Clean and running water
- Adequate light because most slaughter takes place at night. So adequate light is especially important in meat inspections.



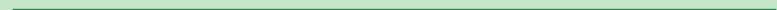
Picture 1: Pig slaughter house at Mkumbi village, Mbinga district (Photo: C. Mkono, 2019)



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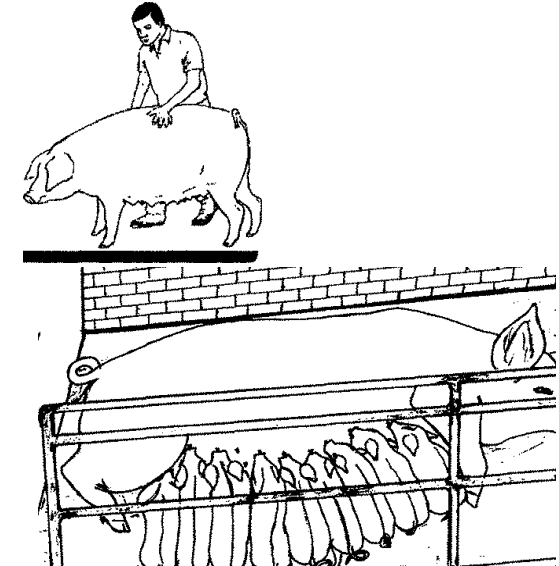
GUIDE

THE BEST PIG FARMING PRACTICES





THE BEST PIG FARMING PRACTICES



**A guide to the best pig farming practices for a small scale pig keeper,
taking into account the productivity, health, and value of the animal**

Issued by the SLIPP Project of Sokoine Agricultural University,
Morogoro, Tanzania through DANIDA Funding

Authors:

Profesa Faustine P. Lekule / Profesa Amandus Muhairwa
Dr. Helena Ngowi / Dr. Daniel Mushi / Dr. Eliakunda Casmir Kimbi

Drawing

Simon John Rwegayura

1. INTRODUCTION

Pig husbandry is one of the fastest-growing activities in East and Southern Africa. Urban growth and population growth have been accompanied by a sharp increase in demand for animal protein. The ability to grow fast, healthy meat quality, and good taste provides a great opportunity for the development of pig farming as a source of income for the breeder. This document provides guides on important pig farming needs, techniques to improve productivity, and disease control as well as guidance on caring for pig rights as a living organism that can suffer pain if not treated properly. Pigs have low maintenance costs, provide fat/oil, generate income, and provide manure. The benefits of raising pigs depend more on the quality of care. Also, remember to use affordable food sources and build infrastructure. The reader is advised to consult a specialist for further advice and also to read reference books on pig farming.

2. THE TRUTH ABOUT PIG

Pigs are very clean and intelligent animals. Given a pig pen with enough space, she can choose a place to sleep, help herself, and keep her body in a very clean condition. Sanitation and environment will ensure that pigs are clean and clean surroundings as we see for many urban and rural pig keepers. Set aside special clothing and footwear for pig work and always take a good shower after working in the pigpen for a long time.

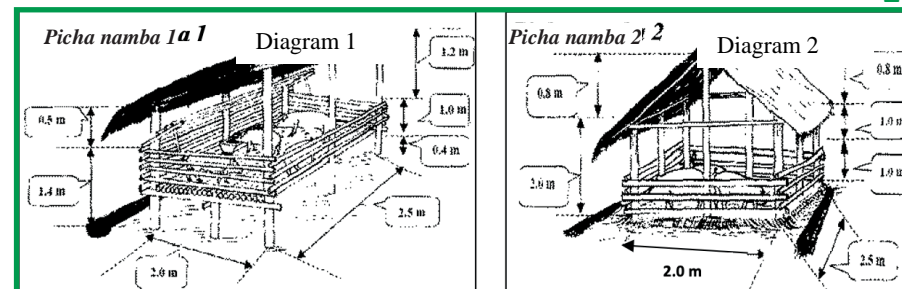
1. PIG HOUSE

There are generally two types of houses needed in pig farming

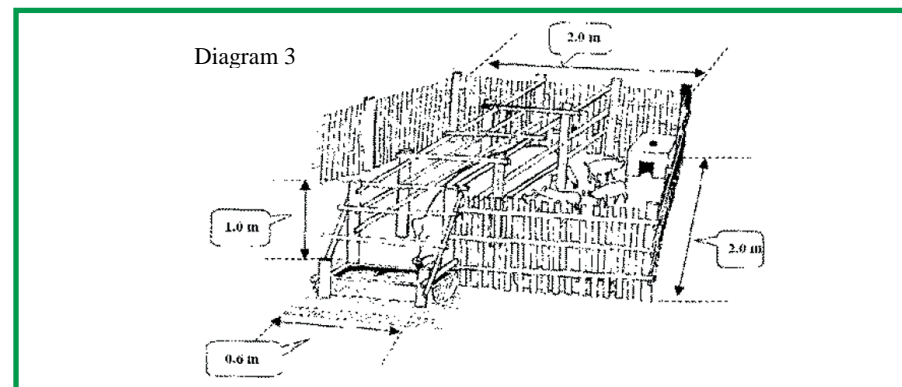
- Pig fattening houses for slaughter
- Pig parents' houses

Basic features of a good pig house: -

- The house should be built in an area with adequate shade
- The house should have enough space
- Build a steep slope to allow water to drain easily
- Have feeders and drinkers
- Have a solid floor made of concrete, and wood that is moisture-resistant. The concrete floor should have a slope that can easily remove dirt inside the pavilion.
- A wooden or timber off-cut floor should provide an opportunity to remove dirt such as faeces from the pigpen.
- Have a drainage ditch, to remove water, urine, and faeces up to the storage pit
- The walls of the pig pens should be strong, able to keep pigs from getting out.
- It needs to be well ventilated inside the pigpen especially if the walls are closed (solid walls)
- The roof can be made from grass, palm fronds, or corrugated iron as shown below



*Pens for four pigs aged four to five months. Dimensions of the pigpen: 2 x 2.5m
Observe the dimensions shown to allow air to pass through and give the pigs enough space.*



2. WHERE TO FIND PIGS FOR REARING

Buy pigs from farms or trusted breeders based on the following.

- Do not breed pigs from the same family, ie brothers and sisters.
- Buy male and female from different places.
- Use expert advice to choose the best pig

Features to look for the best breeding boars:

- Breeding boars should be characterized by rapid growth and should not have any defects of any kind, especially in the legs.
- The sow should have a history of giving birth to 10 to 12 piglets per offspring.
- The sow should have more than 12 nipples.
- The breeding boar should have male genitals i.e. testicles and penis that look straight. He should also be interested in mating.

2. PRODUCTION TECHNIQUES

Taking care of a breeding boar

- Choose a breeding boar that is good, and free from any defect or disease. Separate the males and females to avoid unplanned mating. The pig should not be fat, so do not feed him too much and give him enough exercise so that he does not become lazy.
- Boars start mating sows at the age of 4 months to 9 months. Breeding boars should be allowed to mate only once a week. By the time he is 10 months old, he can mate two to three times a week. At one year of age and older he can mate every day for two to three weeks, then the rest for two weeks. One breeding boar should mate 15 to 20 sows per year.

The small size boar should mate with a small

size sow.

If a large boar mate with a small sow, he may cause her back injury.

The boar need to mate before eating, and not to use it immediately after a meal so that he does not become lazy.

Caring for a pregnant pig

- Pig pregnancy lasts three (3) months three (3) weeks and three (3) days i.e. 114 days
- Pregnant pigs should be given enough food to be added slowly from the normal allowance to 3 - 3.5 kg per day.

Pre-delivery home preparation

- Clean the breeding pigpen with water and let it dry
- Apply dry grass immediately after the house has dried
- Use a lantern lamp or electric lights if you are in cold regions in the piglets section.
- Make a breeding ground using wood or pipes (See picture number 3)

Preparing the sow before giving birth

- Give deworming 10 days before delivery
- Wash them with hand soap and brush
- Keep her in the delivery pen 7 days before giving birth
- Limit nutrition 2 days before delivery
- Only on the day of birth gives the pig drinking water

Pig care

Piglets suck the mother's milk regularly until they are 56 days old. The key things for piglets are listed in Table 1 below:

Table 1: Important things to do for piglets

DAY	SOMETHING TO DO
1	Cut a long umbilical cord with a new razor or boiled scissors and spray Iodine. Cut the sharp upper and bottom teeth. Give the mother pig a little food like half a kilogram
3	Piglets should be given an iron injection. Give them clean drinking water
5	Add the sow's food up to two and a half kilograms
10	Mark the piglets, make sure the pigpen is clean, and give the sow six (6) kilograms of food

Sow mating

- Between four and seven days after weaning, sows enter heat period. The sow that is on heat

should be taken to the breeding boar and not vice versa. Repeat mating 12 hours after the first mating; then repeat mating 2 to 4 times. If the sow does not enter a heat period after 3 weeks she will be pregnant.

Signs of heat

- The genital area will change to red
- Pigs do not rest and urinate frequently
- Mucus comes out of the genitals
- A sow on heat tries to mate her mates and when a boar tries to mate she usually calms down

2. CARE OF A NEWBORN PIGLETS.

Feeding the first milk

After birth and being cleaned, make sure piglets are breastfed, the umbilical cord should be treated with (Iodine 5%) to prevent infections. If the mother dies immediately after giving birth and no other pig can have breastfed the piglets; use cow's milk, add sugar and raw egg stir, and breastfeed using a bottle baby milk.

Heat

Piglets are not born with feathers and do not have enough fat to keep them warm; so it is easy to die of cold. Use a steam or lantern lamp to increase the temperature.

Prevent anemia

Pig milk has a deficiency of iron-rich supplements. So after two or three weeks, the babies begin to weaken due to the lack of these nutrients in the body. To eliminate this problem babies need to be injected with a mineral solution into the muscles two or three days after birth. If the injection is not available, other ways to give the baby these nutrients are by giving them iron tablets, or by giving them the minerals in their tongues or their mother's nipples two to three days after birth.

Cutting teeth

A few days before birth, sharp teeth like needles protrude into two jaws. These teeth hurt the sow when the piglets are suckling; as a result, the sow kicks the piglets. This leads to infant mortality from being kicked and lack of early milk. So the sharp teeth need to be removed with a pair of scissors (See Picture 4), to reduce the effects. Consult a veterinarian for more information.



Picture 4: Pork Producers Association of Kenya

Feeding extra food

The supplementary food should be fed slowly from the tenth day after birth, as at this time breast milk is not enough. Keep giving them this food until they get used to not drinking their mother's milk again. These foods contain nutrients to build the body, strengthen and prevent disease. Pigs should be given this food in large quantities and enough water.

Castration

Piglets that are not needed for breeding purposes should be castrated during the third to fourth week. Castrated Pigs are gentle, strong, heavy, and have no male odor. The veterinarian will give you more information on how to do it.

Stopping breastfeeding

- Stop breastfeeding the piglets when they are two months old and when they weigh 10 kg.
- Give the sow enough food

2. FOOD AND FEEDING

Good nutrition for pigs is one of the most important requirements in the whole concept of productive and profitable pig farming. Pig feed costs about fifty to seventy per cent of the total cost of raising pigs. Among the many problems that lead to the poor productivity of pigs is poor nutrition. Pigs provided with good nutrition will have high productivity, and thus increasing the profitability of the pig farmers.

B. Some of the benefits of good nutrition for pigs are:

1. Good nutrition accelerates the rapid growth of pigs and thus gaining the required weight in a short period.
2. Good nutrition reduces pig rearing cost and thus increases the profitability of the pig farmers because pigs will need only a small amount of feed and will take less time to gain weight.
3. Proper nutrition will reduce the risk of infection.
4. Good nutrition increases the number of eggs produced by female pigs and that will increase the number of piglets that will be born
5. Good nutrition increases the levels of milk that will be produced by sows for piglets thus making them healthier which will enable them to grow faster and reduce the number of deaths in piglets.
6. Good nutrition increases the efficiency of breeding boar and thus increases breeding capacity

C. Nutrients important in pig nutrition

Pigs can eat a wide variety of foods that are easily digested. The balanced pig diet needs to be a mixture of five nutrients, which are:

1. Source of energy foods (such as maize, wheat, rice)
2. Body-building foods/protein (such as sunflower seeds, cotton, and seafood)
3. Mineral foods (such as salt, lime, and crushed bones)
4. Natural vitamin foods (like green leafy vegetables, vegetables, and fruits)
5. Water

D. How to make pig feed

When making pig feed you have to consider the following:

- Its mixture should contain the four nutrients mentioned above
- Choose the type of nutrients that are easily available and affordable in your area
- The type of feed mix is important to take into accounts body Needs as age (eg suckling, weaned, and growing pigs)

Example; table No. 2 Shows different combinations of pig feeds.

1. *Combination number 1:* recommended for pig farmers in areas where maize and sunflower cakes are readily available
2. *Combination number 2:* for those where maize, rice husks, alcoholic distilling residues and sunflower cake are readily available.
3. *Combination number 3:* for those where rice and maize bran is readily available.

Table 2: Different combinations of pig feeds

No	Type	Combination (per cent)		
		No. 1	No. 2	No. 3
1	Carbohydrate source			
	1.Maize bran	70.25	32.00	30.00
	2. Rice bran	-	25.00	33.00
	3. Alcohol distilling residues	-	21.00	-
	4. Sliced maize	-	-	10.00
2	Protein source			
	<i>A. Plant protein</i>			
	1.Sunflower seed cake	22.00	14.00	22.00
	2.Palm seed cake	-	-	-
	3.Boiled and sliced soya beans	-	-	-
	<i>B. Animals protein</i>			
	1.Milled sardines/fish	4.00	2.00	3.25
2. Dried animal blood	0.00	2.25	-	
3	Mineral source			
	1. Table salt	0.50	0.50	0.50
	2. lime	2.00	2.00	2.00
	3. Minerals and vitamins mix	1.00	1.00	1.00
	4. Milled bones	0.25	0.25	0.25
	TOTAL	100	100	100

E. Amount and how to feed the pig

- Pigs need to be fed this type of feed twice (morning and afternoon) or more per day
- The amount to feed the pigs of different breeds and age a group is shown in Table 3.
- In addition to the mentioned foods, pig farmers are advised to provide pigs with their traditional foods such as extra foods like, soft green leaves, pumpkin leaves, vegetables, fruits such as avocados, potato leaves, etc.

Table 3: Amount to feed pigs of different weight

No	Time	Pig weight (Kg)	Amount (Kg per day)
1	After weaning up to a moderate weight	10-17	0.75 kg
2	Weight above moderate	18-29	1 kg
3	Normal weight	30-40	1.5 kg
4	Moderate Heavyweight	41-60	2 kg
5	Heavyweight	61-80	2.5 kg
6	Very heavyweight	81-100	3 kg
7	Pig that is breastfeeding her piglets	120-150	6 kg

HOW TO FEED A SOW BEFORE AND AFTER GIVING BIRTH

1. Pregnancy, childbirth, and weaning

1.1 Three months after mating

- She should be given about 2 kg of feed a day
- This amount should continue until 3 weeks before giving birth

1.2 Three weeks before delivery

- Add food up to two and a half kilograms.

1.3 One week before delivery

- Start reducing feed ration, especially cereal foods (Concentrate rations).
- Add vegetables, soft vegetables, and fruits (laxative meals).

1.4 A day of giving birth

- Do not give any cereal food.
- Give vegetables and soft foods only in small amounts
- Give her enough water.

1.5 1 - 2 days after delivery

- Give her half a kilogram of a balanced diet.

1.6 Day 3 onwards

- Add whole grains in the amount of 1 kg per day.
- Increase to the required level depending on the number of piglets the sow has.

Note:

- The sow needs 3 kg of feed for its normal consumption.
- The sow will need an extra one-third (1/3) of a kilogram of feed for each of the piglets she has.

Example: If a sow has 9 piglets, how much food will she need?

Needs for sow only	Needs from the number of piglets	Amount of food per day
3 kg	One third x 9: (1/3 x 9 = 3 kg)	3 kg + 3 kg = 6 kg per day

- Continue to give the same amount of food until one week before weaning.
- One week before weaning, gradually reduce the amount to 3 kg per day.

After weaning

- Sow should be given a good feed with high levels of minerals and vitamins at a rate of 2 - 3 kg per day.
- This will help her to be on heat soon

8. DISEASES AND HEALTH

The following pig diseases are briefly described to give the pig farmers the knowledge to identify, treat/control them. Consult a veterinarian doctor once you notice these symptoms

Symptoms	Disease	Prevention and treatment
High fever, lack of comfortability, and being aggressive to piglets.	Lack of milk	The sow should be treated with antibiotics if developed fever. Professionals should check the nipples to see if they have problems since birth. Check the sharp teeth of piglet to confirm that they were not removed and removed.
Yellow diarrhea to piglets of 3 weeks old	Diarrhea for piglets	Treatment with antibiotics. Clean the pigpen, drinkers/feeders, and the surroundings often to kill germs.
Flu blisters in the nose, mouth, teats, and hoofs.	Foot and mouth disease	The disease has no proper treatment. Clean the wounds to kill virus/germs, vaccination, quarantine, proper cooking of swill, slaughter, and burial.
Sudden death, nasal bleeding, and bleeding from the anus	Anthrax	Consult veterinary officer/livestock extension officer. The meat is not good and should not be consumed.
The pig becomes itchy, and scratches and rubs against the walls of the pigpen and other objects with the skin between the legs, around the eyes, ears and neck being principally affected.	Mange	Ivermectin (1% injectable) to all pigs. Repeat after 2 weeks. also malathion (1% spray) can be used
Lesions on the body, high fever, incoordination of hind limbs, the animal die the next day after the attack. 95 -100% mortality.	Swine fever	Quarantine, boiling of swill, restriction of movement of meat from infected areas, vaccination Disinfection, no therapy (treatment)

9. CARE, CONTROL, AND BASIC RIGHTS TO HOLD AND LEAD PIGS

Pigs should be held from an early age to help them *get along* well with humans. The pig farmers must learn how to hold, guide, and knock down the pig without causing pain or stress to the animal.

1. Carrying a piglet

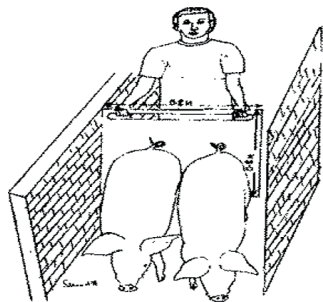
Carry the piglets by grabbing the hind legs, lifting them, and placing the other hand under its belly as shown in picture number 5. There you will be able to treat, relocate or even diagnose her if she has a problem.



Picture number 5

2. Leading an adult pig

Getting the pig to go where you want is possible if you provide a pig guide board. The 80-centimeter-wide board and 80-centimeter-long board can be made using an old door or inexpensive wood. Protect the pig with one board on each side on the right and left while leaving a small space to allow him to see the side of the head, do so while pointing him in the direction you want him to go. You can guide the pig to one board (picture number 6) if there is room to protect the pig right and left as shown.



Picture number 6

3. Control older pigs

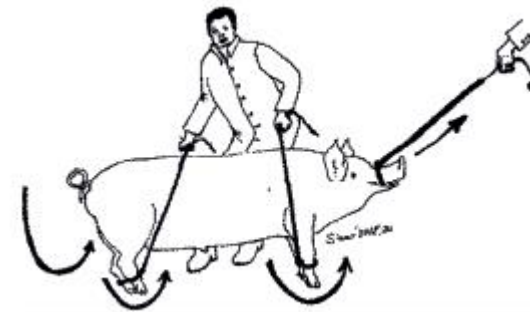
Use a woven hemp rope or pig snare. If a pig is tied with a noose around the upper jaw and pulled forward, he will pull backward as shown in Picture 7. This technique allows you to inspect a pig, inject him, bathe him or even allow you to tie a rope around his legs to knock him down.



Picture number 7

4. To knock down a pig

To knock down a pig, tie a rope around its mouth as shown above (Figure 8). Then tie the front legs together with one rope, and the back legs tied with another rope. Let one person control the mouth rope iii the pig should not walk, the second person should pull the straps one by one while standing (see picture number 8) on the other side as the rope under the pig's stomach pulls, the pig will fall to the ground. Tie the legs tightly to keep the pig from getting up.



Picture number 8

10. PROTECTING THE RIGHTS OF PIGS

- a. Do not beat the pig for any reason
- b. Do not put too many pigs in a small pigpen that does not have enough space. They will fight, get upset, and hurt each other.
- c. Do not leave the pig in the sun; the pig does not have sweat glands the heat will torment him and even kill him
- d. Do not put two boars in the same pigpen especially if they do not know each other; they will fight a lot.
- e. Do not transport pigs to a car that does not have enough space and should be transported in the evening and the morning when there is no heat

Do this

- a. Give the pigs enough space as recommended in this newsletter.
- b. Give them enough food and drinking water
- c. If a pig is sick, it should be treated immediately to avoid unnecessary pain
- d. Slaughter the pigs according to the procedures prescribed to prevent them from dying a suffering death

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2.3 Brochure

5. Always keep your latrine clean and safe.



6. Always wash your hands with soap and water after visiting latrine and before eating.



7. Always use treated or boiled drinking water.



4. Pork should always be cooked thoroughly.



4. Fruits and vegetables should be well washed before they are eaten.



9. If you feel sick visit a health facility early.



10. Always seek veterinarian's advice when your pig gets sick.



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PREVENT TAPE WORM (*TAENIA SOLIUM*)

TO IMPROVE YOUR HEALTH AND WELL BEING



What is tapeworm (*Taenia solium*)?

- *Taenia solium* is a tapeworm transmitted between humans and pigs
- Humans can be infected by an adult worm in the intestine, a condition named "taeniasis"
- Humans can also be infected by *Taenia solium* larvae in muscles, brain, and some other tissues, a condition named "cysticercosis"
- Pigs can only be infected by cysticercosis

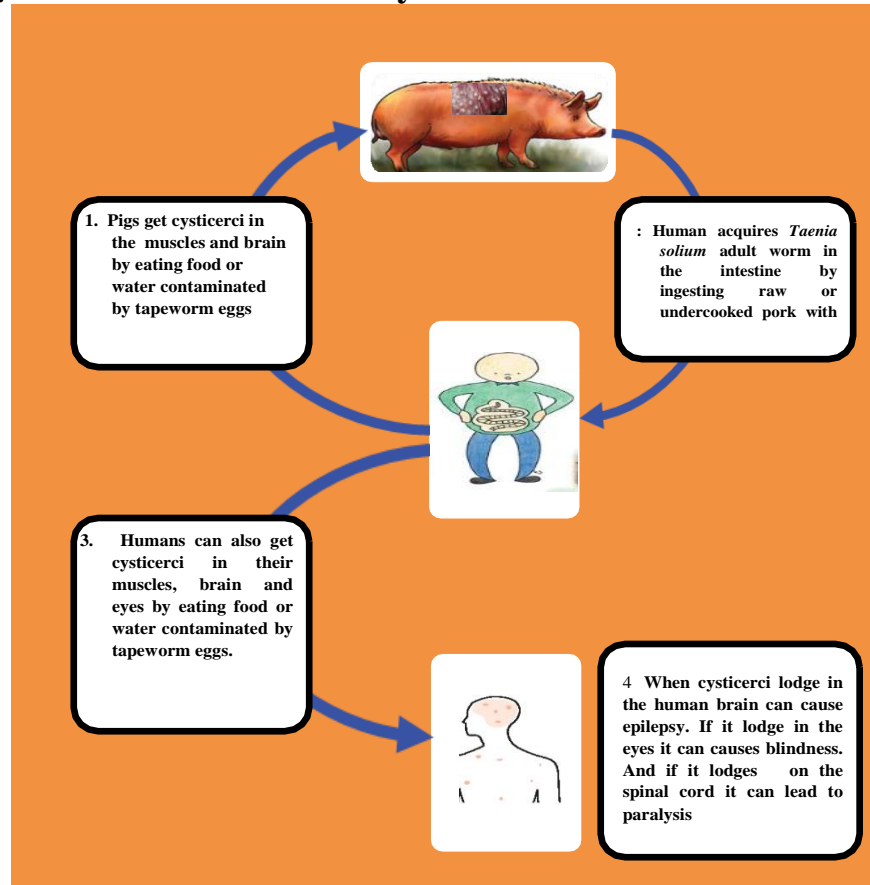
Why is it important to prevent *Taenia solium*?

- Cysticercosis in humans can lead to epilepsy, blindness or other neurological conditions
- Pork infested with *Taenia solium* cysts is unsafe to eat. Thus economic loss

Why is it important to take care of pigs?

- Roaming pigs can eat human faeces and acquire cysticercosis
- If a person eats pork infested with *Taenia solium*, he/she will acquire taeniasis

Taenia solium Lifecycle



What are the important control measures for *Taenia solium*?

1. Always confine pigs



2. Pigs should always be slaughtered in a slaughter facility and meat inspection performed



3. Always use latrine/toilet



Why is it important to maintain good hygiene?

- Consumption of food or water contaminated | human faeces may lead to cysticercosis in humans and pigs.
- Lack of latrines in the household encourages open defaecation, hence possible environmental contamination with *Taenia solium* eggs.
- Inadequate washing of hands in critical times makes human and a potential source of *Taenia solium* egg transmission.

2.4 Poster

LIFE CYCLE OF TAPEWORM (*TAENIA SOLIUM*)

