

**EFFECT OF FARMER'S KNOWLEDGE AND ATTITUDES ON MANAGEMENT
OF THE TOMATO SPOTTED WILT VIRUS IN SIRONKO DISTRICT**

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DECLARATION

I, **Nabuzale Rita**, declare that this dissertation is my original work and that it has never been presented or submitted to any other University, School or Institution of Higher learning for any academic qualification or award.

Signed.....

Date.....

This dissertation has been submitted for examination with the knowledge of my supervisor.

Supervisor: Dr. Peter Atekyereza
Associate Professor

Signed

Date.....

DEDICATION

I dedicate this piece of work to Dr. Sophy Musaana who endlessly encouraged me, for her relentless and selfless parental love and support without which I could not have successfully accomplished my studies.

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ABBREVIATIONS/ACRONYMS

AVRDC:	African Vegetable Research Development Centre
DAO:	District Agricultural Officer
FAO:	Food and Agriculture Organization
FAOSTAT:	Food and Agricultural Organization Statistics
FGD:	Focus Group Discussion
GDP:	Gross Domestic Product
ICIPE:	International Centre for Insect Physiology and Ecology
INSV:	Impatiens Necrotic Spot Virus
IPM:	Integrated Pest Management
IYSV:	Iris Yellow Spotted Virus
MAAIF:	Ministry of Agriculture Animal Industry and Fisheries
NAADS:	National Agricultural Advisory Services
NARO:	National Agricultural Research Organization
NDP:	National Development Plan
NUSAF:	Northern Uganda Social Action Fund
PYSV:	Peanut Yellow Spot Virus
RDC:	Resident District Commissioner
SACCOs:	Savings and Credit Organisations
SME:	Small Medium Enterprises
SPSS:	Statistical Package for Social Scientists
TSWV:	Tomato Spotted Wilt Virus
UBOS:	Uganda Bureau of Statistics

ABSTRACT

Over 80 percent of the population in Uganda live in rural areas and is mainly engaged in subsistence agriculture for their livelihood. Crop farming especially tomato growing is an activity that communities rely on for their livelihoods as well as a source of income for many households in Uganda. Tomatoes contribute to the household income, food and nutritional security yet they are affected by pests and diseases due to poor agronomic practices, lack of improved varieties for high yields and resistance to diseases. Among tomato diseases, tospoviruses have been ranked as the third most important constraint and are spread by thrips as pests and vectors that cause Tomato Spotted Wilt Virus in tomatoes. Therefore, this study was conducted with the objectives of exploring farmer's knowledge, attitudes and perceptions of tospovirus infection, examining the effect of tospoviruses on farmers' livelihoods and the management practices used in controlling tospoviruses in tomatoes in Sironko district.

A cross sectional research design was used to collect both qualitative and quantitative data through use of questionnaires, focus group discussions, Key informant interviews and field visit observations. Using questionnaires, 360 respondents were interviewed, 20 key informants were purposively selected and interviewed and 3 focus group discussions in the 3 sub counties and observations from nearby farmers' gardens were done by the farmers and the research.

The study findings revealed that farmers producing tomatoes in Sironko district are not knowledgeable about tospoviruses in tomatoes. Tospoviruses have an effect on the livelihoods of the farmers in terms of natural, physical, human, financial and social capital stocks. The farmers reported that tospoviruses affect all the capital stocks either directly or indirectly through the financial stock reductions and the spread of the disease to other crops. Financially, quality and yields produced negatively affected market prices. In line with management practises, farmers always use chemicals like dithane to control diseases irrespective of the disease type. Unlike other diseases, it is important to control vectors that spread tospoviruses than the disease itself.

In conclusion, it is important to improve on the knowledge, attitude and perception of the farmers through training like on farm trainings. Effects of tospoviruses on livelihood assets can be improved through organizing the farmers into marketing groups to have a stronger voice that can fetch them better prices for their produce. The management practices can be improved by sensitizing and training farmers on disease identification and use of the recommended sprays for tospoviruses. Tomato farmers need to know the importance of weeding since weeds are hosts for the thrips that spread the tospoviruses.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

The tomato (*Lycopersicon esculentum* Mill.) is a herbaceous fruiting plant which originated from Latin America and has become one of the most widely grown and consumed vegetables in Africa. Tomato is considered to be a top priority among other vegetables in Uganda (Valera 1995; NARO 1999). Uganda's population can generally be characterized as very poor with 86 percent of the population living in rural areas (Aphane, Chadha & Oluoch, 2002). Tomatoes are high value crops which can be produced by all gender groups (males, youths and females).

Tomato production in Uganda contributes to economic development and poverty alleviation because tomatoes is a source of foreign exchange earnings for economic growth over the last 5 years (Sonko , Njue , Ssebuliba & Andre , 2005). About 3,000 small-scale farmers grow fresh fruits and vegetables for export with more than 20,000 smallholders growing vegetables for income (Sonko et al., 2005). The horticultural sector has the potential to contribute to poverty alleviation through income generation from a whole range of marketed products in local, regional and international markets. Production of tomatoes also contributes to rural development in terms of job creation, incomes, public services, widening of the tax base, and human resource development through training of researchers, technicians and supervisors. In addition, the social infrastructure (roads, schools, health centres and electrification) have been set up or extended to the rural areas producing tomatoes.

Tomato growing is one of the most promising areas for horticultural expansion and development in Uganda (MAAIF, 1998) and yet tomatoes are affected by a number of pests

and diseases. Tomatoes are among the vegetable crops grown in the country for both home use and domestic markets and can be grown all year round. Onion, tomatoes, cabbages, garlic and some indigenous vegetable species (Sonko et al., 2005) are among the most widely consumed vegetable crops in Uganda. The tomato is an important cash crop for small-scale growers with a potential for increasing income in rural areas, improving the living standards, and creating employment opportunities for all gender groups.

Tomato is consumed by about 3 million households in every meal in almost every district of Uganda (Mukiibi, 2001; Mwaule, 1995) and it is economically important as a source of income. Tomatoes also have a number of importance for example nutritional values like having beta-carotene an antioxidant, have lycopene a food component known to reduce the incidence of prostate cancer, heart and age related diseases (AVDRC, 2003), also provide good quantities of vitamins A and C. Tomatoes are consumed fresh in combination with salads or used in cooking as a recipe. The popularity of tomatoes and high demand for tomato makes it a high value crop with high potential for value addition and income generation to farmers.

Tomato is annually planted on more than 4.5 million ha worldwide (Food and Agricultural Statistics, 2006) and yet the yields per hectare are still very low and range between 10-14 ton/ha (Nono-Womdim, et al., 1996). The low tomato yields in Uganda are mostly due to poor agronomic practices, lack of improved varieties suited for resistance to diseases (Valera, 1995; Defrancq, 1989; Mwaule, 1995). As such, continued prevalence of viral diseases in tomatoes is considered to be the third major cause of low tomato productivity in Uganda after blight and bacterial wilt. Tospovirus a viral disease has been ranked as the third most important constraint among tomato diseases and has spread all over the world. Tospoviruses are transmitted and spread in nature by thrips *Thripidae* family (*Thysanoptera*) and further

restricted to animals (Van Regenmortel et al., 2000). These include *Thrips tabaci*, *T. setosus*, *Frankliniella occidentalis* (EPPO/CABI, 1997a), *F. fusca*, *F. intonsa*, *F. schultzei* and *Scirtothrips dorsalis* (EPPO/CABI, 1997b). Some of the Tospoviruses are propagatively transmitted by a limited number of phytophagous thrips (Goldbach & Kuo, 1996). *Tomato spotted wilt virus* (TSWV), type species of the genus *Tospovirus*, has an extremely broad host range. Tospoviruses represent the plant-infecting viruses within the family *Bunyaviridae*, a very wide host range and has so far economically the greatest impact of all the viruses (Goldbach & Kuo, 1996; Goldbach & Peters, 1994; Hassani-Mehraban et al., 2005). Most other tospoviruses, e.g. *Iris yellow spot virus* (IYSV) (Cort ez et al., 1998) and *Peanut yellow spot virus* (PYSV) (Reedy et al., 1991), have narrow host ranges or, like *Impatiens necrotic spot virus* (INSV), are mainly restricted to ornamental plants (Law et al., 1990).

The geographical host range of tospoviruses encompasses nearly every major agricultural area on the globe (Jones, 2005). Tospovirus affect a wide variety of plants causing severe disease in vegetables such as tomatoes, pepper, onions, lettuce and cabbage (Gera, Kritzmann, Cohen, Racciah & Antignus, 2000). However, not much tomato virus research work has been done in the East African region and this is partly because of the costs involved in virus identifications. As such, the few available reports from neighbouring countries list only six tomato viruses among which Tomato spotted wilt virus (TSWV) was reported in Tanzania, South Africa, Zambia, Zimbabwe and Madagascar as early as 1969. Tospovirus attack leads to a loss in production and quality due to the effects the disease has on both the plant and the fruit. Farmers have devised means on how to manage diseases that attack tomatoes and some of the literature reviewed has been discussed below:

Vegetable farmers are knowledgeable about the different pests and diseases that affect their crops however perceptions on how to manage the diseases differs due to cultural values and norms involved. A study was conducted in Botswana Vegetable farmers' knowledge and perceptions of pests, diseases and pest management practices on tomato and other crops and indicated that they were knowledgeable about pests and diseases affecting the vegetable crops (Obopile, Munthali & Matilo, 2008). In line with this, research was conducted in Botswana on management practises and reported that 98 percent of vegetable farmers heavily relied on use of pesticides as a management practice to control the pests. Their perceptions were such that on noticing the presence of either pests or diseases, pesticides are applied. In Zambia, 75 percent indicated that they used pesticides to control tomato pests and also used other traditional practices like handpicking and destroying affected plants as a management practise. In a survey conducted in Kenya, it was indicated that 66 percent of farmers interviewed applied pesticides on noticing pests on the crop in the production of tomatoes (Waiganjo, Wabule, Nyongesa, Kibaki, Onyango, Wepukhulu & Muthoka, 2006). And as management practice for tomato pests and applied at regular intervals. In addition, these farmers were also aware of the effects of the pesticides on livelihoods. By its nature, traditional agriculture is characterized by diversity of practices and genetic resources where farmers manipulate and derive advantages from local resources and natural processes. There have been several cases of tospovirus incidences; however, little has been documented on farmer knowledge on how to manage tospoviruses.

The first report on occurrence of TSWV in East Africa was in 2001 (Wangai, Mandal, Pappu & Kilonzo, 2001) in Kenya and is widely spreading to other countries around Kenya including Uganda. In Uganda, production is seriously constrained by several pests and diseases due to inadequate pest and disease control as stipulated among the constraints to the

performance of the agricultural sector National Development Plan (NDP), 2010/2015. Thrips are among the most frequently reported pests of tomato in East Africa both as direct pests and vectors of tospovirus diseases and cause Tomato Spotted Wilt Virus in tomatoes. In spite of the diseases affecting tomatoes, farmers have come up with management practices for the diseases. Management of diseases caused by tospoviruses has become a challenge for sustainable production of vegetables in small holder farming systems as can cause economic losses as high as 100 percent in tomatoes (Wangai et al., 2001) yet these losses are quite high for the small scale farmer who relies on tomatoes for their livelihoods.

In relation to knowledge on management of diseases, research has been conducted on management of other tomato diseases like bacterial wilt, blights and mosaic but little or no literature on knowledge by farmers on management of tospoviruses. In spite of the extensive damage that these viruses can cause, there is very little information on farmers' knowledge, perceptions, attitudes and management of tospoviruses.

1.2 Statement of the Research Problem

Tospoviruses rank among the ten most detrimental plant viruses worldwide and the recent occurrence of the virus and spread into the hosts has sparked concern among agriculturalists and horticulturalists (Prins & Goldbach, 1998). Tomatoes are susceptible to tospoviruses which are capable of damaging up to 100 percent (Wangai et al., 2001) of the tomatoes leading to losses and thus affecting production levels, livelihoods, markets and income levels. Scientific research has been conducted on identification, symptoms, how it is spread and incidence of tospoviruses. There is no investigation on how farmers manage tospoviruses in tomatoes in Sironko district therefore, there is need to conduct this study in order to understand farmers' knowledge, attitudes and management practices of tomato tospoviruses in the district of Sironko.

This study was carried out to seek answers to a number of research questions which included: What knowledge, attitudes and perceptions do the farmers have on the management of tospoviruses in tomatoes? This question found out whether respondents are knowledgeable about tospovirus, What the effects of the tospoviruses on the farming communities were and how do tospoviruses in tomatoes are managed in the community? This question looked at how tospoviruses affected crop yields, income levels as well as the socio-economic effects on livelihoods. What coping strategies have the farmers and other extension workers come up with to manage tospoviruses in tomatoes? (both Indigenous knowledge on management and management by the extension workers).

1.3 Study Objectives

1.3.1 General Objective

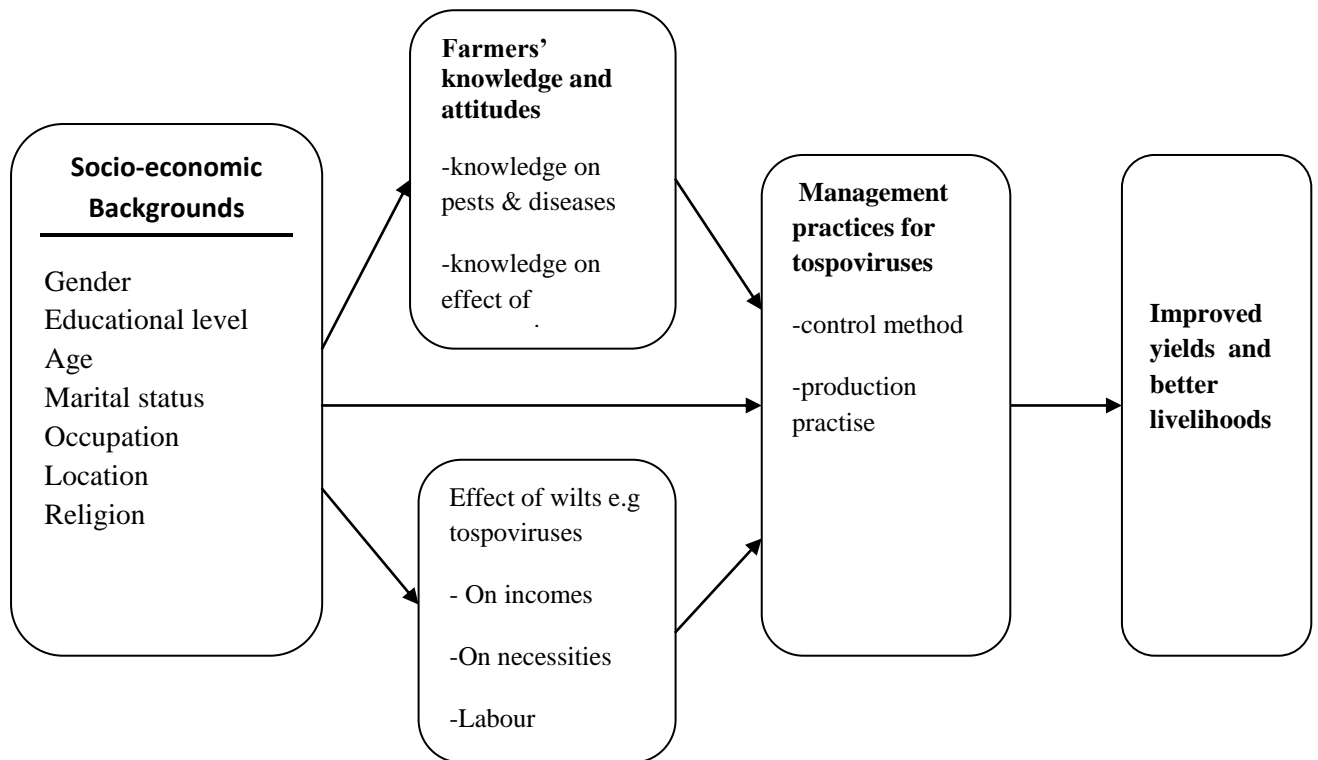
The general objective of the study was to explore the effect of farmer's knowledge and attitudes on management of the tomato spotted wilt virus in sironko district.

1.3.2 Specific Objectives

The specific objectives of the study were;

- i) To identify farmer's knowledge on tospoviruses in tomatoes
- ii) To evaluate farmers' attitudes and perceptions of tospovirus infection in tomato production.
- iii) To examine the effect of tospoviruses on farmers' livelihoods.
- iv) To evaluate management practices used in controlling tospoviruses in tomatoes.

1.4 Conceptual Framework



The socio- economic issues affect the farmers' knowledge, attitudes, perceptions and management practices on pests and diseases. The management practices are the dependent variables that are affected by the farmers' knowledge, perceptions and attitudes on tospovirus infection in tomatoes. On the other hand, socio-economic factors are the intermediate variables affecting both the independent and the dependent variables. Farmers that are knowledgeable about tospoviruses and their effect on livelihoods will manage the disease better in tomatoes thus getting increased yields which will fetch more and better incomes resulting into improved livelihoods.

1.5 Scope of the study

The study covered farmers' knowledge, attitudes, perceptions and management practices of insect pests and diseases that affect production of tomatoes and subsequent effect on livelihoods. It also investigated production practices that are used in controlling tospoviruses

in tomatoes. The study was conducted in Sironko district in the sub counties of Bugitimwa, Bumasiswa and Masaba, Eastern Uganda on the foot hills of Mount Elgon. The research conducted by other researchers on management of tospoviruses was also used. The reference period is the last 10 years because tomatoes have been in the district for a long time and to be compared with the diseases of tomatoes over time.

1.6 Significance of the study

The findings of this study will contribute to the measures devised to improve farmers' incomes and their livelihoods, management of diseases and subsequent increase in yields. This study will be of significant contribution to the country's food security and poverty reduction as tospovirus infection in tomatoes will be controlled hence increasing yields. This way, farmers' incomes will increase and they will have resources to enable them access other household necessities like animal protein, access to education, access to medical care, self-esteem and empowerment of household members.

The results from the study will also contribute to the policy makers, the Ministry of Agriculture Animal Industry and Fisheries during policy formulation on extension services on pests and disease management for increased production of tomatoes. The results will also enable farmers have better knowledge, change of attitudes and perceptions towards tospoviruses hence better management practices may be adopted. The findings will provide up-to-date literature for academicians and researchers on thrips and tospoviruses that affect the tomato farmers' livelihoods in Sironko. It will also be a basis for further research by International Center for Insect Physiology and Ecology (ICIPE) and National Agricultural Research Organisation (NARO).

1.7 Definition of Key Terms

Livelihoods; Livelihoods are extensively discussed among academicians however, they all have a common consensus that livelihood is about ways and means of making a living. Definition of livelihood by Ellis, 2000 ; Chambers, 2000 have one feature in common that livelihood deals with people, their resources and what they do with them to improve their livelihoods. In addition, livelihoods revolve around resources like land, crops, seeds, labour, knowledge, cattle, money and social relationship.

Knowledge; Knowledge during the study looked at what farmers know about the tospovirus, if they are aware that it might be the cause for the low yields.

Attitudes; Attitudes looked at how farmers respond to tospoviruses as diseases that attack and affect tomatoes. Attitudes are farmers' feelings towards tospoviruses and how they manage them.

Perceptions: During this study, perceptions looked at what tomato farmers believe tospoviruses are by using their indigenous knowledge and natural instinct.

Management Practises; This looked at how farmers respond to the diseases as well as how they control them both as individuals and as a community before interventions from outside are sought.

Tospoviruses; Tospoviruses are viral diseases that are spread by thrips (plate i& ii) as vectors and affects both plants and fruits in tomatoes. The Tomato Spotted Wilt Virus (TSWV) is a tospovirus diseases found in tomatoes and other crops like onions and TSWV symptoms vary and depend on the stage of growth when plants are infected, the cultivar and environmental conditions. At seedling stage, symptoms in tomatoes include leaf bronzing, wilting and necrotic leaf spots. There fruits are paler red while the skin is yellow with

concentric rings. Affected tissue will dry up when the damage is severe. The tospoviruses also cause systematic infection in most plants infected and this leads to stunting of the entire plant. Damaged leaves may become papery, distorted, lose their color, roll, and drop prematurely (EPPO, 2004).

Plate i: Brown Coloured Thrip



Source: David *et al.* 2001 page 22

Plate ii: White coloured Thrip on a Tomato leaf



Source: David *et al.* 2001 page 24

Thrips feed by sucking plant sap and in the process reduce plant sap and transmit viruses from plant to plant or from alternative hosts like weeds to cultivated plants.

1.8 Organization of the Dissertation

The dissertation has been arranged into six chapters whereby *Chapter one* describes the background to the study, Statement of the research problem as well as the research questions. The dissertation also describes the study objectives both general and specific, scope of the study as well as the significance of the study. In addition, Chapter one also looks at the key definitions and the organization of the dissertation. *Chapter two* looks at the literature review in relation to the study objectives both globally, African continent and specifically Uganda. This chapter also discusses the theoretical and conceptual framework used in relation to the topic under study. *Chapter three* discusses the research methodology used during the study and includes among others; the research design, area of study, study population, sampling procedure, sample size and selection, data collection and instruments, data processing and analysis, quality control, procedure, ethical considerations and limitations of the study. *Chapter four* gives a presentation and discussion of study findings whereby it talks about; the demographic characteristics of the respondents, specific objective 1 which presents farmer's knowledge, attitudes and perceptions of tospovirus infection in tomato production; objective 2 which presents findings on the effect of tospovirus on farmers' livelihoods and how they respond to the disease in tomatoes; and finally objective 3 which presents management practices used in controlling tospoviruses in tomatoes. *Chapter five* is the last chapter that gives a summary of study findings, conclusions made and recommendations drawn on how to manage tospoviruses in tomatoes through understanding farmer's knowledge, attitudes and perceptions.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This section will focus on the literature on tospoviruses, their effect on the livelihoods of farmers growing tomatoes as well as farmers' knowledge and attitudes on the management of the tospovirus disease. It is reviewed from a global, regional, down to East Africa then to Sironko as the study area. The literature will review agriculture and rural livelihoods, tomato in people's livelihoods, knowledge, attitudes, perceptions plus management practices of pests and diseases, theoretical and conceptual framework. In order to understand the farming households under study, demographic data was collected as a basis to know the activities that the farmers are involved in. Similar approaches were used by other people to study community and farmer responses to new technologies for pest and disease management) in different districts of Uganda. A number of issues on agriculture, importance of tomatoes in livelihoods will be discussed below:

2.2 Agriculture and Rural Livelihoods

Agriculture plays an important role in rural development as it provides a source of livelihood for the rural community. Through agriculture, communities in the rural areas produce goods and provide services that generate incomes for them. For example, there are people who are employed off farm to provide labour and also employment in agro processing industries. Through agriculture, the infrastructure is improved and this attracts market into the rural areas that produce crops for sell.

Rural populace rely on agriculture for their livelihoods and yet face numerous and high risks which limit rural incomes leading to predominance of subsistence agriculture and dependence

on common property natural resources, especially for poorest households. Rural households operate in a risky environment, where the incidence of shocks and crisis like floods, crop and animal losses through disease, health crisis, and land grabbing by powerful groups or individuals also affects livelihoods. Subsistence agriculture is still prevalent, and harvesting of natural resources remains the main safety net for poorer households. Faced with low and seasonal agricultural revenues, rural households are also constantly looking for work or other income generating activities, the majority of which will be temporary and poorly rewarded.

The majority of the world's extremely poor people live in rural areas and their livelihoods are bound closely to smallholder agriculture as; farmers, laborers, transporters, marketers, processors of produce and as suppliers of non-agricultural services to households whose income is principally agriculture-derived (Kydd, 2002). Smallholder agriculture is presently a key sustainer of the majority of the world's poorest people's livelihood.

Tomatoes are part of the activities for a good livelihood of the farming communities in Sironko. The demand for tomatoes is high and one can make good money out of it no wonder one of the tomato varieties grown in Uganda is called "money maker". With the rapid urbanization taking place the demand for tomato related fast food products continues to grow in the urban centers of Uganda. This creates incomes for the farmers growing tomatoes in rural areas through the growing trend for tomatoes in urban centers and this market may become larger in future as eating habits change country wide. The majority of tomato growers sell their tomatoes on-farm hence reducing losses that could be incurred during transit.

Apart from sorting and grading no other post- harvest care is done on tomatoes. Growers pack tomatoes in boxes weighing 50kg or baskets of 15kg. Market opportunities for tomato

paste outside Uganda continue to grow both within and in the European Union with a share of 30 percent in EU import value. Tomatoes form an important part of the farming communities and this has been seen in other places as well. The next section looked at the importance of tomatoes as a contributing factor to the livelihoods.

2.2.1 Significance of Tomatoes for Livelihoods

Production of tomatoes ranges between 0.4ha-0.6 ha plot size and is concentrated in mountain areas of Mbale and Kabale districts and in the Banana-Coffee farming system in the Lake Victoria crescent in Southern Uganda (Sonko et al., 2005). Tomatoes are grown as a sole crop, under rain fed conditions as staked, unstaked or pruned plants. The most common varieties grown include Money maker, Marglobe, San-marzano, and Amateur Rodade.

Tomatoes generate employment opportunities for the poor household members for example factories have been set up to add value by making tomato sauce and chili sauce thus creating jobs for the rural populace as well. There has been a net increase in the level of production of tomato paste in the last 5 years, from 616 tons to 940 tons per annum. The tomato paste produced mainly feeds into the production of tomato sauce which is the main product demanded by the local Uganda market with the introduction of fast food restaurants. The demand for tomatoes is high and one can make good money out of it no wonder one of the tomato varieties grown in Uganda is called “money maker”. With the rapid urbanization taking place, the demand for tomato related fast food products continues to grow in the urban centers of Uganda. This creates incomes for the farmers growing tomatoes in rural areas through the growing trend for tomatoes in urban centers and this market may become larger in future as eating habits continue changing country wide. The majority of tomato growers sell their tomatoes on-farm hence reducing losses that could be incurred during transit. Apart

from sorting and grading no other post- harvest care is done on tomatoes. Growers pack tomatoes either in boxes weighing 50kg or baskets of 15kg. Market opportunities for tomato paste outside Uganda continue to grow both within and in the European Union with a share of 30 percent in EU import value. Farmers face challenges in the production of tomatoes like diseases and among them are the following constraints discussed herein:

2.2.2 Constraints of Tomato Production

Tomatoes are a source of livelihood the world over but are affected by pests and diseases and among the diseases are tospoviruses. Among the tospoviruses are the Tomato Spotted wilt Virus which has a number of symptoms. Symptoms are illustrated by reference to a selection of economically important vegetables, ornamental plants and industrial crops. TSWV can induce a wide variety of symptoms, which may vary on the same host species with the cultivar, age, and nutritional and environmental conditions of the plant. Further strains of TSWV with different biological properties have been isolated.

On tomatoes, plants show bronzing, curling, necrotic streaks and spots on the leaves. Dark-brown streaks also appear on leaf petioles, stems and growing tips. The plants are small and stunted as compared with healthy plants. The ripe fruit shows paler red or yellow areas on the skin. Sometimes, affected plants are killed by severe necrosis. On *Capsicum annum*, symptoms are mainly stunting and yellowing of the whole plant. Leaves may show chlorotic line patterns or mosaic with necrotic spots. Necrotic streaks appear on stems extending to the terminal shoots. On ripe fruits, yellow spots with concentric rings or necrotic streaks have been observed. On lettuces, infection starts in leaves on one side of the plant, which becomes chlorotic with brown patches. The discoloration extends to the heart leaves and cessation of growth on one side of the plant produces characteristic symptoms.

Plate iii: Tomato fruits infected with tospoviruses



Source: David *et al.* 2001 page 10

The virus has caused losses to farmers and there is need to understand how farmers are dealing with the disease. Tomatoes are infected with tospoviruses and these reduce quality and yields thus impacting on the livelihoods of the people through reduced incomes.

In Hawaii, Tomato Spotted Wilt Virus (TSWV) started causing major epidemics in lettuce and tomato crops in 1980s and it moved to Georgia, South East America in mid 1990s (Culbreath, Csinos, Bertrand ; Demski 1991). Tospovirus in tomatoes was first reported in Europe in 1991 (Peters, Wilijkamp, Van de Wetering & Goldbach, 1996) and is now found in more than 12 European countries (Lebas & Ochoa, 2007). Since then, tospoviruses have spread to vegetables like tomato, lettuce and pepper. In France, first attack by TSWV occurred in late 1980s affecting floral and vegetable industries (Peters *et al* 1996). TSWV was the first tospovirus reported to occur in tomato cv. Pito Early in Iran, in the Varamin area of Teheran province (Bananej et al., 1998), soon followed by reports of INSV (Shahraeen et al., 2002) and PBNV (Golnaraghi et al., 2002).

In Africa, the incidence of tospoviruses was identified in South Africa and now damages many crops including tomato, potato and many others. TSWV continues to be a concern to tomato growers in South Africa, Algeria, Cote d'Ivoire, Egypt, Libya, Madagascar, Mauritius, Nigeria, Niger, Senegal, Sudan, Tanzania, Tunisia, Zaire, Zimbabwe and Uganda (Rybicki et al., 1999; EPPO, 2004). In East Africa, there has been incidence of tospoviruses for example in Kenya, TSWV was first reported in 1998 on tomatoes in Nakuru district in the rift valley and has been spreading to different areas of Kenya (Wangai et al., 2001). With the spread of TSWV to areas of Kenya, it means that it is rapidly spreading to other countries surrounding Kenya including Uganda since the virus can also be spread through a number of ways like seeds. The virus has caused losses to farmers and there is need to understand how farmers are dealing with the disease.

In the case of Uganda, poor tomato yield is attributed to three factors, (a) lack of improved varieties, which are well suited for high yield and resistance to diseases, (b) Occurrence of pests and diseases, and (c) lack of knowledge on sustainable agronomic practices (Defrancq, 1989; Hansen, 1990; Mwaule, 1995) basically because of absence of enough information on them (Valera, 1995). Tomato plants and fruits are commonly attacked by numerous insects and diseases; therefore, some control measure must be taken to raise a successful crop.

Among the farming constraints are factors that make the production of different crops difficult for example among the constraints affecting tomato production include: Availability of pesticides in terms of price and proximity, limited market for the produce, expensive transport to the markets, limited land leading to soil exhaustion, low yields, pests and diseases, poor soil fertility and scarce labour for hiring. These constraints result in lower potential incomes from tomatoes and other cash crops thus having an impact on the

livelihoods of the farmers as can't afford access to other services like health and education for their children. In a study carried out in Kumi district, it was indicated that Late blight and thrips were a common disease in the area. When plants are affected by TSWV, marketable yield is lowered due to systemic necrosis (Mavric & Ravniker, 2001).

The Context of Diseases in Tomato is such that, in Hawaii, Tomato Spotted Wilt Virus (TSWV) started causing major epidemics in lettuce and tomato crops in 1980s and it moved to Georgia, South East America in mid 1990s (Culbreath et al., 1991). Tospovirus in tomatoes was first reported in Europe in 1991 (Peters et al., 1996) and is now found in more than 12 European countries (Lebas & Ochoa, 2007). Since then, tospoviruses have spread to vegetables like tomato, lettuce and pepper. In France, first attack by TSWV occurred in late 1980s affecting floral and vegetable industries (Peters et al., 1996). TSWV was the first tospovirus reported to occur in tomato cv. Pito Early in Iran, in the Varamin area of Teheran province (Bananej et al., 1998), soon followed by reports of INSV (Shahraeen et al., 2002) and PBNV (Golnaraghi et al., 2002).

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With the spread of TSWV to areas of Kenya, it means that it is rapidly spreading to other countries surrounding Kenya including Uganda since the virus can also be spread through a number of ways like seeds. The National Development Plan (2010-2015), indicates that the decline in production patterns is due to pests and diseases.

Western flower thrips remain hidden in flower buds making it difficult to detect before severe feeding damage is evident. They injure host plants by direct feeding as they feed by piercing and sucking out plant sap. This type of feeding results in silvering and curling of leaves followed by necrosis of plant tissue. Thrip feeds and egg laying (oviposition) also leads to injury of fruits. Western flower thrips are the most efficient vectors of tomato wilt spotted virus especially the larval stage. The western flower thrips remain hidden in flower buds making it difficult to detect before severe feeding damage is evident. They injure host plants by direct feeding by piercing and sucking out plant sap leading to silvering and curling of leaves followed by necrosis of plant tissue. Thrip feeds and egg laying (oviposition) also leads to injury of fruits.

Some farmers tend to know the crop losses and damage due to viruses but they do not associate them with thrips. Effective management and control of thrips would result in reduced incidences of tomato wilt virus however, farmers use calendar pesticide sprays resulting in over use of pesticides and pest resistance to the chemicals in use. For example in Florida calendar pesticide applications resulted in a high population buildup of thrips.

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Tomatoes are infected with tospoviruses and these reduce quality and yields thus impacting on the livelihoods of the people through reduced incomes. The National Development Plan (2010-2015), indicates that the decline in production patterns is due to pests and diseases. Given the information on tospoviruses as seen from a global, African and Ugandan context, there is also knowledge, attitudes and perceptions available on tospoviruses.

2.3 Knowledge, Attitudes and Perceptions of Tospoviruses

Farmers' knowledge and experiences of a disease plus the practices they use to manage the disease needs to be known by those that bring in interventions in order for them to identify points of potential entry and appropriate interventions. Practices for disease control developed for resource constrained farmers by researchers with no prior consideration of farmer's own knowledge and practices will not be adopted thus calling for a linear dissemination of knowledge.

It was also found important to find out the level of knowledge about a disease and how they acquired it plus the way they control the disease in order to appreciate the gaps for intervention.

What the farmers know about a problem, their past experience with a similar problem and how much they consider it to be a problem usually determines the extent to which they will go on to solve the problem. Farmers generally know that Tomatoes have serious disease problems; however, they do not at times distinguish between various diseases let alone knowing how to prevent them.

Farmers are knowledgeable about pests and diseases that affect their crops through their experience, but treat the diseases with pesticides on seeing symptoms without analyzing what kind of disease it is. It is important to understand how they perceive of these pests and diseases within their local area, their attitudes as well as how they respond to the diseases and pests as they affect livelihoods. People's attitudes and perceptions about a practice need to be sought before implementing any program. Pesticide use has been the most common technique for controlling pests in the world. There is no direct means of control however, method of control is aimed at the thrips vector or application of sanitation measures to limit spread of the virus. With these losses farmers cannot sit back and watch their produce being attacked by tospoviruses. Farmers have their own perceptions, attitudes and farming practices to help deal with the tospoviruses and among these are traditional methods and use of pesticides. Among the traditional methods are use of ash, neem tree, use of dung and early harvesting of tomatoes while still green as is the case in Nigeria (Banjo, Lawal, Fapojuwo & Songonuga, 2003). Similar methods were also used in managing Tomato leaf curl virus disease in Southern India and vegetable pests and diseases in Botswana (Obopile et al., 2008)

Globally, in Iran, Integrated Pest Management (IPM), organic agriculture and biological control have been suggested as appropriate approaches for pest management (Asgarinya, 2010; Molazadeh, 2010). A survey was conducted in Botswana on Vegetable farmers'

knowledge and perceptions of pests, diseases and pest management practices in 2004 and it was indicated that 98 percent of farmers relied heavily on the use of synthetic pesticides to control pests. Their decision to apply pesticides was mostly on noticing the presence of a pest or disease. (Obopile et al., 2008). In Nigeria, a survey conducted indicated that farmers were knowledgeable about pests, their impact and control measures. 89 percent were aware of insect- pest problems and majority of the farmers adopt diverse number of traditional methods in pest control and chemical treatment was not used extensively by the farmers as indicated by 64.9 percent (Banjo et al., 2003). Farmer participation and integrated pest management (IPM) in Sub Saharan Africa have been noted as important trends in agricultural research and extension. Over two decades, attempts to develop and disseminate IPM in developing countries have been met with limited success (Yudelman, Ratta & Nygaard, 1998). Farmer's perception and role in developing and adapting technology is usually neglected (Okali & Sumberg, 1986). In India, it was observed that farmers had limited knowledge of pest management as well as the consequences of pesticide use in vegetable cultivation (Mahantesh & Alka, 2009). Farmers perceived that over the years the severity of pests is increasing and thus greater quantities of pesticides required for controlling pests. In Tanzania and Uganda, 89 percent use pesticides as a control measure for tomato pests. They further reported that misuse of pesticides was significantly different for age, gender and levels of education in Kumi and Iganga districts. Similar findings were reported by Waiganjo et al., 2006 in Kirinyaga district of Kenya.

In addition, about 99 percent of farmers interviewed in Kumi agreed that they used inorganic fertilizers for production of tomatoes. With the use of pesticides, costs of production are high and this leads to negligence by farmers who may lack resources to buy pesticides thus evaluating their management knowledge is important for increased yields.

In Uganda, among the main constraints identified by extension workers in reaching farmers were negative attitudes of the farmers towards change in farming practices (NDP, 2010). Most farmers prefer to use chemical pesticides as indicated by a study done on integrated pest management in eastern Uganda and many were not aware of the alternative pesticides for managing pests, crop diseases, small insects as well as beneficial insects. Among the farmer knowledge and perception that exist for insect and diseases management are crop rotation, fallowing, increased plant populations, roguing diseased plants, hand removal of pests, use of homemade concoctions and using resistant or tolerant varieties. Control is by synthetic pesticides that are expensive, may not be readily accessible, and may not be used correctly and in the right quantities.

From the literature cited, farmers are knowledgeable about diseases but lack information on pests that cause the diseases. Most times when tomatoes show signs they are not treated in isolation but spray the plants with pesticides they are familiar with. Tospoviruses are very innocent that one doesn't notice the effect but feels it more in terms of yields harvested and prices offered due to quality. It is therefore important to evaluate whether farmers know that tospoviruses exist, if they know their effect on marketable yield and incomes of the fruits and how they are managing them as a community growing tomatoes thus the need for this study. Furthermore, understanding traditional knowledge and management practices might give an identification of local resources and different ways of how farmers control pests as well as the ecological knowledge and perceptions of local communities.

2.4 Farmer's Management Practises of Tospovirus.

Farmers grow a number of crops and have encountered a number of diseases that affect tomatoes. Through experience, the farmers have come up with coping strategies to manage diseases though they tend to pay more attention to diseases and not pests. The perceptions on management are in line with what the community does in relation to cultural beliefs. A number of cultural practices have been reported to reduce incidence and severity of viral diseases. Among the socio-cultural practices on the management of tospoviruses include: use of an integrated management package combining both cultural practices and insecticide application, uprooting infected plants mulching and intercropping with other crops plus crop sanitation (Waiganjo et al., 2006). These methods have effectively reduced tomato yield losses, virus incidence and spread, even though they are simple and common. In some instances knowledgeable farmers use indicator plants and weeds like *Petunia* to let them know that there are viruses in the area.

2.5 Effect of Tospoviruses on livelihoods

TSWV has become an increasingly important factor contributing to economic losses in many food and ornamental crops throughout the world. Destructive outbreaks of TSWV have occurred in France and Spain in protected and field crops of tomatoes, *Capsicum* and *Anemone*, associated with the establishment and rapid spread of the vector *Frankliniella occidentalis* (EPPO/CABI, 1997c). Crop losses may be as high as 100 percent (Berling et al., 1990; Rodriguez, 1990). In some areas of Argentina, Brazil, Canada, Denmark, Italy, Netherlands, UK and USA, TSWV has become one of the most important diseases. The most seriously affected crops include *Capsicum annum*, chrysanthemums, *Cyclamen*, *Senecio cruentus*, *Sinningia* spp. and tomatoes. In Uganda, the disease may be a silent killer of Tomatoes due to the way farmers perceive and manage it in their gardens.

Management of TWSV is costly and complex since it requires human (skills, knowledge, experience, capabilities), financial (money to buy inputs), social role of women and gender associated constraints) and natural (land) capitals to achieve effective solutions. TWSV presents one of the risks and uncertainties of Tomato production since the production depends on the farmers' ability to predict weather, prices, pest and disease incidence and the use of different crop management practices. Even with the educated rich farmers the level of awareness of a problem through mass and print media greatly influences their perception, attitudes and final behavior. Therefore the less exposed the farmers are the more they fail to manage tospoviruses and the higher the effect on their livelihoods through reduced quality, quantity and prices of the products in the market. The lower the perception of a problem the lower the number of farmers that use effective control measures. The higher the development of human capital the higher the perception and the higher the ability to take risks that result in improved yields and lower losses.

Social factors like the farmers age, number of people in the household, level of education and cultural norms affect the level and effectiveness of adopting and using new technologies. Associations of farmer's age, farm size and perception of a pest or disease influences the way they manage the said pest or disease. Poverty of households has also been associated with the household demographic behavior in Pakistan. Farmer knowledge, perception and management of vegetable pests and diseases in Botswana and India were also associated with gender and household demographic data (Obopile et al., 2008).

The economic standing of a household has been reported to affect the social confidence of females to attend extension meetings or training workshops. This is due to lack of clothes and

confidence to attend meetings (Khalid, 2002). Poverty also affects their ability to afford and use chemical pesticides. Pesticide misuse and health risks vary with gender roles, levels of education and age for examples in Ghana, farmers below 45 years were vulnerable to pesticide poisoning since they were used to spray vegetables. Similar results were reported for vegetable farmers in Eastern Uganda and Ghana. Gender often influences knowledge, acquisition and on-farm roles and responsibilities. These differences need to be understood in order to design appropriate technologies for small holder farms. Gender based knowledge differential occurs because men and women have different agricultural activities assigned to them by cultural norms. Failure to assess these differences can impede technology design and adoption.

In dealing with individual households or communities, it is important to know their poverty levels by looking at the status of their capital endowment. These usually determine whether the household or community adopts easily or does not adapt to given technologies. The sustainable livelihood framework is constructed around the identification of capital assets that individuals can access, augment and manage in their needs and opportunities to sustain their livelihoods. The five capitals that have direct impact on tomato growers in Uganda include the ones indicated herein.

Natural capital: These are natural resource stocks from which resource flows are derived, including land, water, biodiversity, landscapes etc. They may be renewable (forests) or non-renewable (land). Equitable access and control of these resources results in faster development.

Social capital: This refers to capital stocks such as networks, memberships to groups, relationships and the wider institutions of society. Social capital is a set of horizontal associations among the people who have an effect on the productivity of the community. The

associations include networks of civic engagements and spatial norms that create a sense of belonging for all

Human capital: This is a collection of the capabilities of the individuals required to provide solutions to problems. These include skills, knowledge, and ability to work plus creativity acquired through formal and informal education and experiences to improve productivity. Education and training improves quality of production, skills and knowledge enable one to make money. All forms of competencies that improve one's knowledge, social and personality attributes, creativity and ability to perform by providing labour. This encompasses all forms of actions that affect people's social, biological, cultural and psychological status.

Financial capital: This is the cash at hand that enables them to finance investments. This is usually in form of financial assets such as savings, loans, credit, remittances, pensions and other transfers. This capital stock helps us to know how fluid the household or community is as a means of affording to purchase inputs. For rural communities, this would include things like the main occupation of the adults in the household and even the off-farm labour provision and needs by the farmers.

Physical capital: This is the basic built infrastructure, tools and equipment (roads, wells, hospitals, energy, and communications etc.). This capital stock becomes useful in analyzing poverty that stems from lack of physical assets. Among the assets put into consideration can be land ownership (landless or near landless) livestock, tractors Small Medium Enterprises (SME).

A strong and sustainable capital base is inherently empowering to the community. A strong capital base is content led and does not address asset functions or functioning.

2.6 Theoretical Framework

There are many theories about extension that have been looked at but for this study, the agricultural extension theory will be used. There are four major models in agricultural extension: linear ‘top-down’ transfer of technology; participatory ‘bottom-up’ approaches; one-to-one advice or information exchange; and formal or structured education and training. Despite criticisms of linear technology transfer models, there is still a need for access to reliable scientific information, just as there is a need to provide for active participation by farmers in research and development processes. One-to-one exchange of information and advice, whether from farmer to farmer or from professional adviser to farmer (and vice versa), will continue to be important. So too will be the lifting of levels of formal education and training among farmers. New information technologies will facilitate some forms of education, training and information exchange, but will need to be supplemented by other extension strategies. For a technology to be adopted, it must be in line with the knowledge that the farmer has as well as putting in mind their cultural norms, beliefs and values as a community. Management practices to work well must be integrated with what the community uses so ones needs to understand farmer’s knowledge, attitudes and perceptions towards management of diseases is understood.

In the study it is important to transfer knowledge to the community through a linear ‘top-down’ transfer of technology in order to understand what the community perceives of the knowledge through a participatory ‘bottom-up’ approach where farmers give the informed

information. In addition, having a one-to-one advice or information exchange enables an integration of knowledge and perceptions as perceived by the community and not as seen by the researcher. As extension staff provide formal or structured education and training, it is important to understand the concepts on disease management as seen by the community as you learn more from the locals than they would learn from you. No single model or strategy is likely to be sufficient by itself as farmers' knowledge and perceptions are as important in the management of tospovirus as access to reliable scientific information through extension service providers and through research and development. As farmers also exchange information on a one-on-one, it is easier to manage diseases as perceptions and attitudes are shared and best adopted if learnt from fellow farmer. This theory informs the study that it is important to understand farmers' knowledge, perceptions and attitudes as this feeds into better management practices for tospoviruses (Black, 2008).

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter discusses the research design, area of study, population, sampling procedure, sample size and selection, data collection and instruments; it will also further look at the data processing and analysis, quality control, procedure, ethical considerations and limitations of the study.

3.2 Research Design

A cross sectional research design was adopted to understand the characteristics of the respondents. Both quantitative and qualitative data was collected where by quantitative was aimed at measuring number demographic data like number of households and management practices available for tospoviruses in tomatoes. The design also enabled the researcher conduct an in-depth investigation into the problem under study. With this research design, the set objectives on farmers' knowledge, attitudes, perceptions and management practices and livelihoods were achieved from a large number of respondents spread over the parishes randomly selected as a representative sample. Both primary and secondary data was collected on knowledge, attitudes and perceptions as far as management of tomato tospovirus was concerned.

3.3 Area of Study

The research was conducted in Sironko district. Sironko is one of the 22 districts found in eastern Uganda. It borders Kapchorwa in the east, Kumi in the west, Nakapiripirit in the north and Mbale in the South (Uganda districts hand book, 2007-2008). Sironko was selected

because it is a high land area with a high altitude, potential with annual average rainfall of 1,191 millimeters per annum. These conditions are favourable and the temperature facilitates the production of tomatoes. The study aimed at high altitude areas accessible with tomato as the main cash crop thus the selection of Sironko district as the area of study. Research has been conducted in other crops and diseases affecting tomatoes, however, knowledge on management of tospoviruses is still lacking thus the choice for Sironko as the area of study. Sironko is a food basket and has been known for producing tomatoes consumed by the neighboring districts.

Map 1: Districts Location Map



Map 2: Map of Sironko District

3.4 Population of the Study

Farmers growing tomatoes were the study population with both males and females involved in tomato production, marketing, extension, agro stockists. The three categories were selected because they are in better position to provide information as far as tomatoes are concerned. Farmers have the experience over time in dealing with the tomatoes therefore their knowledge, attitudes, perceptions on tospovirus and translation of its effects were important to the study. The service providers improve farmers' livelihoods through giving advice on disease and pest management while the marketing actors boost their incomes through buying the farmers' products. This is because as marketing actors, the quality of tomatoes determines the price offered for them hence justifying the need to involve them in the study.

3.5 Sampling Size and Procedure

The sample size for this study was 360 households. The population for Sironko district is 309,000 people of which more than 10 households grow tomatoes (Sironko district report, 2009). Three sub counties were purposively selected with nine parishes purposively sampled for production of tomatoes. Out of the 9 parishes selected, forty households were randomly selected to avoid biasness giving a total of 360 household adults both females and males actively participating in tomato production. Households, direct observations, Key informants, marketing actors and focus group discussions were organized as being knowledgeable and had experience about tospoviruses, their management and effect on livelihoods of tomato farmers.

The sample size was determined using Sarantakos formula for estimating sample size as seen below:

Sample size= pqZ^2/E^2 where by:

$$p= 5$$

$$Q= 100-5=95$$

$$Z \text{ at } 95\% \text{ confidence level}=1.96$$

$$E= 2.25 \text{ (Sarantakos 1997).}$$

Sample size= $5 \times 95 \times (1.96)^2 / (2.25)^2 = 475 \times 3.842 / 5.063 = 1825 / 5.063 = 361$. Therefore, the sample size for this study was 360 respondents.

Purposive sampling procedure was used in the early stage in the selection of Sironko district as the study area. Sironko is a high altitude area good for the existence of tospoviruses, accessible with production of tomato as the main cash crop hence the selection of Sironko. Comparing the sub counties, it was found that not all sub counties had intensive cultivation of tomatoes except Masaba, Bumasiywa and Bugitimwa thus the reason for purposively selecting them because the. These sub counties grow tomatoes and have experiences with tospovirus and data on management practices of tospoviruses was collected from informed sources spread over the three key sub counties. Within the three sub counties, three parishes were randomly selected from each totaling to nine parishes. These parishes included Buboolo, Bufupa, Bukinyale, Bulwala, Bumaguze, Bundagala, Buwetye, Elgon and Kisali) from which households were randomly selected to avoid biasness. This random selection also helped in capturing different information on gender, education, knowledge, perceptions, attitudes and management practices of tomato tospoviruses.

A multi stage sampling procedure was used in the selection of the survey population. A list of twelve sub counties was provided by the District NAADS co-ordinator, Sironko of which three were identified as key tomato production areas. While in the sub county, a list of parishes within a sub county was provided on manila paper with the help of the NAADS sub

county co-ordinator. From this list, three key tomato producing parishes were identified with number and names of households that existed. A simple random sampling technique was used to sample the 40 households in each of the nine sub counties in order to avoid biasness totaling to 360 households ((9 parishes x 40 households = 360 households). 25 key informants were interviewed (3 sub county chiefs, 9 sub county coordinators, 1 DAO, 1 production officer, 1 district NAADS co-ordinator, 10 marketing actors were selected). These were also interviewed because they are knowledgeable about challenges particularly tospoviruses that affect the tomatoes. The marketing actors included transporters, middlemen and buyers because the price, quality and quantities of tomatoes and onions required of the farmers are determined by them. A Focus Group Discussion was conducted with 8 farmer group leaders participating (four females and four males).

3.6 Data Collection

Both qualitative and quantitative data collection methods were used to get primary, secondary data. Quantitative data collection is referred to as collecting data that explains phenomena by collecting numerical data that are analysed using mathematically based methods in particular statistics).

3.6.1 Data collection methods

Quantitative data was collected in order to collect numerical data on number of males and females that grow tomatoes, what percentages are knowledgeable about tospoviruses and management practices available in managing tospoviruses in tomatoes. Quantitative data collection method used was survey method for household interviews. Surveys were used for quantitative data collection because they enabled collection of data at the same time given the limited resources and short time. On the other hand Qualitative data was collected using

focus group discussion and key informant interviews. This helped in providing useful information in clarifying and expanding quantitative findings on farmer's knowledge, perceptions of tospovirus and how tospoviruses are managed in tomatoes.

3.6.2 Data Collection Instruments

The instrument used for quantitative data collection was a questionnaire for household interviews of tomato producing communities to collect primary data because these helped get informed data. Adult males and females actively participating in tomato production were interviewed.

On the other hand, interview guides were used for qualitative data collection using key informant interviews and focus group discussion. Each of the 8 parishes had a farmer group leader participating in the focus group discussion except Kisali. This made 8 farmer group leaders of which four were females and four were males participating in order to compare knowledge across the gender. The topic was introduced to the participants who were encouraged to freely participate in the discussion. An interview guide was used and it focused on key issues of knowledge of tospoviruses, perceptions and attitudes towards tospoviruses in tomatoes as well as management practices available and effect of tospoviruses on livelihoods.

Among the key informants interviewed were the District Agricultural officer, sub county NAADS co-ordinators, Extension staff, transporters, middlemen. A check list was used in gathering information to double check and clarify on some issues that may not have been clear when individual interviews at household level were conducted (see appendix II and III).

The instruments that were used to collect quantitative data were questionnaires. This face to face interview enabled an in-depth understanding of the themes of knowledge, perceptions, attitudes of tospoviruses and its effect on their livelihoods (see appendix 1, section B and C

of the questionnaire). FGDs would help in data collection within the shortest time possible given the limited finances available as participants are interviewed in one place.

During FGDs, observations were made in the farmer fields for identification of tospoviruses so as to explore whether farmers knew that tospoviruses existed and perceived them a problem in their livelihoods. Observations were also done in the farmer fields so as to explore whether farmers knew that tospoviruses existed and perceived them a problem in their livelihoods.

Plate iv: Identification of Tospovirus during the Focus group discussion.



Source: Masaba Sub county (August 2011)

3.6.3 Procedure

A letter of introduction was secured from Makerere University Faculty of Social Sciences (Department of Sociology). This letter was presented to the district records office and a copy availed to the L.C V chairperson and the RDC. The DAO was also given a copy of the letter and together with the NAADS Co-ordinator guided the student on areas that purposively

grow tomatoes in the district. After this briefing, the chiefs of the three sub counties were informed and were expecting the student and in turn also introduced the researcher to the parish leaders who further introduced the researcher to the extension staff that guided the student in the villages.

3.7 Data Processing and Analysis

Both quantitative and qualitative data was collected and analyzed. Data was collected, coded, entered and analysed. Quantitative data was analysed using Statistical Package for Social Scientists (SPSS) version 11 in the computer. Quantitative data was analyzed and presented in tabular form using percentages, frequencies to describe the study findings on knowledge, attitudes and perceptions as well as management practices available for tospovirus infections.

Qualitative data from Focus Group Discussions and key informant interviews was analysed in line with key information collected on the themes of knowledge, perceptions, management practices and effect of tospoviruses in tomatoes.

3.8 Quality Control

A pretest of the questionnaire was conducted before the actual field data collection started which helped take care of gaps, unclear questions and other important information that could have been left out during designing of the survey tool. Research assistants were selected on the basis that they have some experience in tomato production and were trained on the tospoviruses and its symptoms prior to data collection and symptoms of the tospovirus shown to them both on the plant and in pictures. On a daily basis, the researcher would go through the questionnaire and check for any errors that could have been made and correct them in the

field. Data collection was in a participatory manner and respondents were consulted for permission before the questionnaire was administered, conducting field visits and taking of photos. During data collection, data was recorded, photographs taken, verbatims written for further report writing.

3.9 Ethical Considerations

Before administering questionnaires, the consent of the respondents was sought and the study objectives were explained and, clarification was made to them about their voluntary participation. Finally, the respondents were assured of confidentiality and anonymity of information gathered at all levels of the study, respondents were not asked to directly identify themselves through their names. The research was able to seek consent from the respondent before executing the questionnaire and names of respondents were not included in the final report.

3.10 Limitations of the Study

During the research, there were some challenges that were met as had been envisaged. It was a rainy season so it kept raining heavily throughout the whole period of research. Some areas especially the mountainous areas were not accessible however; the researcher had to extend to the following day. In other areas, there was burial so conducting research was tricky thus extending the period.

It was anticipated that the respondents may not be willing to respond, however the respondents offered all the time and information as was indicated to them through the questionnaire. This could have been because their consent was sought before executing the

questionnaire and hence participated willingly. For ethical purposes, if such people are not willing, then the interview would be terminated. Language barrier was also a limitation to the study as the respondents are Lumasaba speaking people however; a research assistant was trained and comfortably translated some difficult words which the researcher failed to understand in order to collect meaningful data. Other languages like Luganda or Swahili were used in case of failure to communicate so as to hear from the respondents directly. Demonstration and field visits were used to ensure information is fully collected for the study.

CHAPTER FOUR

PRESENTATION AND DISCUSSION OF FINDINGS

This section presents the findings of the study according to the study objectives except the demographic characteristics.

4.1. Demographic Characteristics of the Respondents

In order to understand the respondents' characteristics, information on age, gender, ethnicity, religion, marital status and education level were important in understanding the type of people interviewed and how best to provide interventions. The social demographic characteristics captured by this study include: Gender, age, education level and marital status of the respondents as indicated in table 1.

Table 1: Demographic Characteristics of Respondents. (n=360)

Demographic characteristics	Frequency	Percent	Cum. %
1. Gender of the respondent			
Female	56	15.6	15.6
Male	304	84.4	100
2. Age of the respondent			
18-20	51	14.2	14.2
21-30	95	26.4	40.6
31-40	70	19.4	60.0
41-50	82	22.8	82.8
Above 50	62	17.2	100
3. Educational level			
Nursery	2	0.6	0.6
Primary	198	55.0	55.6
Secondary	79	21.9	77.5
Tertiary	18	5.0	82.5
Never went to school	63	17.5	100
4. Religion of respondents			
Catholic	276	76.7	76.7
Protestant	58	16.1	92.8
Moslem	8	2.2	95
Born again	6	1.7	96.7
Seventh day Adventist	12	3.3	100
5. Marital status			
Single	29	8.1	8.1
Married	326	90.6	98.6
Divorced	2	0.6	99.2
Widowed	3	0.8	100

The results in Table 1 indicate the findings during the study. The findings indicate that Tomato growing is male dominated with 84.4% being males.

The respondent's age ranged between 18 as minimum and maximum being above 50 years. The most active age group involved in tomato production is age 21- 30 years with mainly the males participating. Age was also compared with gender and indicated that the males were more involved in tomato production than the females.

The findings of the respondent's education level shows that had attended school with the highest level attained being primary (55%) with less than half of these continuing to

secondary level (21.9%) and 17.5% having not attended formal education. Across gender, it was found that more males (84.4%) attended school than the females.

4.2 Farmer's Knowledge on Tospoviruses

This section was important in understanding knowledge on acreage under tomato production as compared to other crops, varieties grown and which variety is most susceptible to tospoviruses, trainings attended in order to identify the best information avenue in case of need for capacity building. The section also looked at farmers' perceptions and attitudes towards tospoviruses, effect of the tospovirus in terms of yields, marketing, household necessities. The findings revealed that there are a number of crops that are grown in the three sub counties of Bugitimwa, Bumasifwa and Masaba in Sironko district and these include as shown in table 2:

Table 2: Major Crops Grown

Crops grown	Frequency	Valid percent	Cumm.%
Tomato	163	45.3	45.3
Beans	60	16.7	61.9
Maize	48	13.3	75.3
Potatoes	21	5.8	81.1
Coffee	21	5.8	86.9
Banana	27	7.5	94.4
Cassava	3	0.8	95.3
Onion	17	4.7	100.0
Total	360	100	

Tomatoes, beans, maize, onions, cassava, bananas, potatoes and coffee as the main crops grown and are cultivated on mainly less than an acre of land. The farmers gave reasons why

they grow tomatoes and one farmer in Kisali said “*tomatoes need limited space and yet I get money to sustain my family*”.

The farmers also ranked the crops basing on the importance they put on each crop by way of usefulness to their livelihood needs. Tomatoes were ranked mainly as cash crops and in the first position. Tomatoes are mainly grown as a cash crop; however, other crops are grown for both cash and food crop. Results similar to these were reported for Mangoes in Kumi district and South Africa.

4.2.1 Knowledge on Tomato Varieties Grown

Tomatoes are the major cash crop of the area and among the varieties grown are Cal J/Kamongo, Afriseed/East Africa, Moneymaker, Holland, Marnglobe, Onex, France and Hybrid 614.

Table 3: Tomato Varieties Grown

Variety grown	Tally	Percent
Cal J/Kamongo	360	100.0
Afriseed/East Africa	320	88.9
Moneymaker	140	38.9
Holland	60	16.7
Marnglobe	50	13.9
Onex	35	9.72
France	30	8.33
Hybrid 614	25	6.95

Multiple responses according to the findings revealed that the most preferred variety among these is Cal J/Kamongo as all the respondents interviewed expressed that they grow this variety. The reason for preference of Cal J is because it has a longer shelf life than the others. Cal J/Kamongo variety is grown in combination with the other varieties especially Afriseed/East Africa. The findings revealed that Hybrid 614 is the least grown as are not knowledgeable and it is not readily available.

Plate v: Cal J (Kamongo) variety grown



Source: Cal J variety at Gombe market (August 2011)

Farmers have come up with local names for these varieties for easier identification by them for example Cal J variety is commonly referred to as “kamongo or kainja”. The findings also showed that varieties are known by their trade name like East Africa because East Africa Seed Company produces tomato seed thus the choice of name. The District Agricultural Officer a key informant interviewed said that *“Farmers know and identify varieties by Company names which are indicated on the packet.* In addition, the results by the agro-stockists indicated that tomato varieties are repackaged into smaller quantities that farmers can afford. Sometimes the packets are relabeled preferably in the interest of the stockiest and sold to the unsuspecting farmers.

The findings showed that tospoviruses exist in the area and are mainly affecting moneymaker variety. The respondents mistake tospoviruses with early and late blight. The respondents refer to tospoviruse as “kakwensulo”. During the field visit in the farmers’ garden, it was observed that tomatoes found in the garden had symptoms of tospoviruses. Farmers during

the field visit also showed the most destructive disease were tospoviruses as indicated by 60.5% of the farmers.

Plate vi: Symptoms of Tospovirus on Tomato fruit



Source: Farmer field, Bugitimwa sub county, 2011

The uneven ripening and yellowish rings on the fruit as seen in the plate iv is a symptom of a tomato affected by tospovirus. These kinds of symptoms were found during observations both in the fields and market centres during focus group discussions and key informant interviews.

4.3 Farmers' Perceptions on Tomato Tospoviruses

The findings revealed that shedding off of leaves is a sign of maturity and harvesting of the tomatoes. *"Farmers know that it is normal for the leaves to dry up"*, said the sub county NAADS co-ordinator one of the key informants.

Another perception by the respondents is that the tomatoes are harvested early to prevent ripening in the garden, rotting and risk of being eaten by rats. These tomatoes are harvested raw and sold off before symptoms of tospoviruses appear on the fruit.

The farmers' perception is such that tospoviruses have similar symptoms with other tomato diseases. All tomato diseases affect both the leaves and fruit and this is confusing to them so they do not bother differentiating but manage them the same yet some are fungal while others are viral.

The farmers also have a perception that tospoviruses are spread through seed and during the wet season. This is because to them the losses are more felt and observed during the rainy season and similar symptoms were observed in other plants like onions.

4.4 Farmers' Attitudes on Tospoviruses in Tomatoes

The findings revealed that respondents' attitudes towards tospovirus is such that they believe that tospoviruses occur due to abrupt weather changes, delayed spraying or use of little quantities of chemicals to spray. The farmers' attitude is such that they spray against the diseases irrespective of whether it is a virus or fungi. All they do is go to the agrosshops and buy chemicals for managing the symptoms of tospoviruses.

Farmer's attitude towards the thrips is that these are destructive and lead to losses as most of the yields are lost. To the farmers anything that affects the plant and destroys it is "munyafu" as it deforms it. Their attitude is such that the cause for deformity in plants are pests thus a negative attitude.

In addition another attitude observed is that the solution towards early maturity is to harvest the fruits early and sell them off while still green. "*We harvest the tomatoes and sell the fruits while still raw in order to avoid losses*" said Namugowa in Nabatu village. The attitude is that they spend money and time growing the tomatoes and cannot imagine yield losses due to "kakwensulo" This way the customers notice the tospovirus symptoms as they start ripening and hardening.

The farmers' attitude towards is that the tomatoes are hardened due to hail stones which hit the fruits in the rainy season. This poor attitude leads to poor management of the disease and increased spread thus poor quality of tomato fruits.

The attitude is that the farmers do not sort and grade tomatoes as to them this is a waste of time and yet some tomato varieties tend to destroy other good varieties because some have longer shelf life than others. This attitude always affects the price offered and yet the farmers sometimes need a little money to meet their household needs.

These poor attitudes tend to have an effect on identification of tospoviruses, management as well as effect on livelihoods.

4.5 The Effects of Tospoviruses on Farmers' Livelihoods.

Livelihoods are multidimensional covering not only economic but political, cultural, social and ecological aspects. Livelihoods also comprises of capabilities, assets and activities required for a means of living.

The findings revealed that the respondents are economically empowered through the sale of tomatoes. The respondents' livelihoods depend on incomes from production sale of tomatoes. The respondents expressed that incomes got from tomatoes is used to buy food thus making households food secure as well as having the ability to access more food of different types using finances earned from tomatoes.

Findings showed that tomatoes also play an important role of boosting the farmers' nutrition because tomatoes are not only grown for sale but are also consumed by the farmers. Tomatoes have good food values like vitamins and minerals which are good for building the body. This keeps the farmers healthy and boosts energy to grow other crops as well. The energy can be provided as labour that can be hired on other farms at a fee thus earning these farmers an extra income for the household.

Farmers' livelihoods depend on incomes got from production and marketing of tomatoes. These incomes enable households to meet their basic needs like health, clothing as well as education for their children. This is made possible with money earned from tomatoes thus improving farmer's livelihood.

In addition, this economic empowerment also makes the farmers socially secure because they tend to have a sense of belonging. This is because farmers selling tomatoes can afford to buy cloths and attend meetings comfortably since they are smart and have a voice to contribute towards issues discussed for the good of the community.

The findings revealed that tomatoes are a good source and contributes towards the tax base as taxes are levied on tomatoes that are ferried to markets. These are a source of revenue for the sub county which assists in provision of latrines like the one established in Gombe market. These taxes help in bringing services closer to the people. Income from tomato production contributes to the livelihoods of the farmers however; the tomatoes are attacked by disease causing pests which compromise the quality thus affecting prices offered. These low prices reduce incomes earned thus impacting negatively on the livelihoods of tomato farmers. This chapter looked at the effect of tospoviruses on livelihood in terms of assets like natural, human, financial, social and physical capital. Existence of the tospovirus affects capital stocks leading to effects on livelihoods. Among the effects identified during the study include the following findings presented:

4.5.1 Tospovirus Effect on Natural Capital

During the study, it was found that land as one of the assets provided by nature for the production of tomatoes for their survival is affected by tospoviruses. Attack by tospoviruses infects the soil on which tomatoes infected with tospoviruses is grown. It was found that

more than 80% of tomatoes had been affected by tospoviruses and one of the respondents shared that , “I donot know what am going to do with the next season as I willnot have seed for planting.” The tospoviruses were also visible on other crops like onions. The natural capital assets that were identified by the respondents included land, land scapes and water resources. Land as one of the natural capital is acquired through inheritance, hired or bought by the farmers for agriculture. The farmers reported that tospoviruses tend to affect the land available because the disease remains in the soil and continues being spread to new tomatoes that are planted. Tospoviruses affect land as a natural capital by reducing or blocking the means of acquiring the land other than through inheritance (Chambers & Conway, 1993).

The results indicated that on the other hand livelihoods have been affected by tospoviruses in terms of natural capital as sometimes more land is hired in order to have more quantities planted so as to realize more yields despite the existence of tospoviruses. In order to realize more yields, the farmers buy pesticides so as to control Tomato diseases yet pesticides like Ridomil are systemic, expensive and stay in the plant for about two weeks yet farmers spray weekly. This weekly spray wastes money that would be used to meet and improve livelihoods of the farmers. Similar results were reported elsewhere. The money that is spent on hiring more land due to diseases can be used in meeting other necessities like food, health, school fees, clothing and other household requirements thus an effect of tospovirus on livelihoods.

The results indicated that during drought, there is limited water yet the tomatoes tend to require water during this period. Tospoviruses affect the soil fertility as the farmers would rather continue growing tomatoes on the same land without rotating for fear of spreading the disease to other areas. In other instances, the farmers abandon the soil and look for better land forcing them to hire better land for cultivation thus an effect of tospoviruses on the natural capital a livelihood asset because they are not able to meet their basic requirements.

On the other hand, livelihoods are affected by tospoviruses in terms of natural capital as sometimes more land is hired in order to have more quantities planted so as to realize more yields despite the existence of tospoviruses. Fruits infected with diseases are sprayed with chemicals that are toxic to the health since they don't use protective gear. The money that is spent on hiring more land can be used in meeting other necessities like food, health, school fees, clothing and other household requirements thus an effect of tospovirus on livelihoods.

The livelihoods in Sironko are affected due to the landscape as a natural resource being destroyed by shifting cultivation and killing of natural enemies to thrips by chemicals. The land is so mountainous that heavy rains sometimes wash the plants away leading to losses yet money from the sale of these tomatoes can be used in meeting necessities that improve livelihoods like access to medical attention, education and houses.

Tomatoes also need to be supported off the ground on sticks (staking) yet forests as a renewable natural capital is affected as trees are not replanted to prevent deforestation. Existence of tospoviruses in tomatoes leads to slow process of deforestation as farmers continuously need tree branches for staking as well firewood. This affects the weather pattern where one farmer said, *“we used to have rains all day long almost all year round”*. This has changed and there are fewer rains coming these days. This change of pattern affects the cropping pattern as well as harvesting and incomes expected thus an effect on access to food as a livelihood. Encroachment on forests as a natural resource leads to deforestation which involves removal of soil covers and yet this makes the soil unstable resulting in landslides.

4.5.2 Tospovirus Effect on Human Capital

Human capital looked at both formal and informal education acquired by the farmers. Farmers acquire skills, knowledge, and ability to work and creativity to improve productivity.

Therefore, the more formal education one attends, the more skills acquired. Results on school attendance indicated that majority of the people have not attended school (42.6%) and have mainly stopped in primary therefore, they do not have formal education. Farmers who have not accessed formal education and training seem not to have varied knowledge and skills on managing tospovirus disease so they risk getting poor quality tomatoes there by fetching low prices. This reduced income affects livelihoods as some basic needs are not met thus an effect of tospovirus on livelihoods. Low yields results into reduced incomes that would be used to pay school fees for higher level education of children.

Labor that would be used for production of other crops is diverted to spraying and management of tospoviruses. The tospovirus diverts labour that can be used to grow more crops to sorting and grading the tomatoes and remove rotten and affected tomatoes. Tomato is a cash crop that is given more time at the expense of food crops. During absence of tospovirus, farmers afford to eat body building foods that boost the body enabling the farmers to hire out their labour in order to get extra incomes. This way tospovirus limits alternative sources of income to meet household necessities thus affecting livelihoods.

Tospoviruses have an effect on livelihood because the family tends to have very little food security because the tomato is looked at as a crop grown for cash and the others as food. In the absence of tospoviruses, there are high yields realized and in turn increased incomes. However, with the existence of tospoviruses, low incomes are earned and this impacts negatively on households ability to buy a variety of food that boosts health, builds the body and gives it energy. Tospoviruses tend to lead to an unbalanced diet which leads having stunted children due to an unbalanced diet thus an effect of tospovirus on livelihoods. Lack of vitamin A in children leads to reduced development and bad sight. Vitamin A is one of the food values that is high in tomatoes.

The results also revealed that the human capital in relation to tospovirus diagnosis is not well developed for example; most farmers gave virus symptoms similar to sun scotch. This result indicated that there is a gap in knowledge and perception about tospoviruses yet labor is required to control the disease. In addition, this labor is also required in sorting and grading rotten and affected tomatoes. This labor is used more in tomato production which is a cash crop at the expense of food crops. This impacts on the food security which could lead to limited food supply and this affects livelihoods as food is bought instead of being grown.

4.5.3 Tospovirus Effect on Financial Capital

From the results, it was identified that tospoviruses affects financial capital which has an effect on livelihoods. Usually the farmers tend to save seed for the next season but if the tomato is lost due to tospoviruses then there is no seed left for the next season. This loss forces the farmers to get seed on credit or borrow money from friends or loans from the bank. The loans interfere with the production of other crops which could fetch some money to meet household necessities. Lack of securities also affects access to capital as the farmers usually rely on their harvests in order to get profits for paying back the credit. Profits fetched from tomatoes and other crops grown are used in the purchase of chemicals used in managing the tospoviruses yet the chemicals are expensive to buy. This affects livelihoods as limited finances are saved for the wellbeing of the households thus an effect of tospoviruses on the livelihoods.

Tomatoes infected with tospovirus disease tend to affect the market and demand of the produce as lower prices are offered for affected tomatoes. The farmers tend to fetch better yields in the absence of tospoviruses however, with attack of the tospovirus, the yields and incomes earned reduce due to effect of tospoviruses on marketing of tomatoes. The tospovirus discolors the tomatoes, stunts the fruit leading to uneven ripening of the fruit,

symptoms that the market will not stand but look for alternative markets. This poor quality reduces market demand making the farmers get between 10,000/= to a few shillings from their produce thus reducing their capital base as an effect of tospovirus.

The tospoviruses also affect the demand for tomatoes due to poor quality of tomatoes (hard and with stones in them) thus fetching low prices. Tospoviruses lead to reduced yields of tomatoes because of the existence of symptoms that lead to losses due to rotting of crops in the garden as well as fruits during harvesting. The yields also reduce as indicated by 88.1% of the farmers and thus fetching low incomes. The crops affected by tospoviruses have registered fewer yields than crops with little or no existence of tospoviruses. With low yields and low incomes, it becomes difficult for the farmers to get credit through borrowing from fellow farmers or savings and credit organizations. Tomatoes farmers usually form themselves in groups called SACCOS where they save and borrow in turns. The money borrowed from the group helps farmers pay school fees for their children, buy pesticides as well seeds for planting. One who lacks a source of income tends to have limited financial capital thus can't join the group as well as accessing credit. This affects livelihood in terms of financial capital. These results indicate that the farmers need some training in good agronomic practices like identification of good quality varieties and proper crop hygiene in order to improve on the yields for commercial production. Tomato farmers also use their gardens as security to get loans but not when the garden is infected with tospoviruses.

Similar results were reported by other workers in relation to loss of financial capital due to disease damage (Chambers & Conway, 1992).

4.5.4 Tospovirus Effect on Social Capital

Among the livelihood assets affected by tospoviruses is the social capital. Social capital is gained or lost through social assets such as networks, membership to groups, relationships and the wider institutions of society. Farmers in Sironko district depend on income from tomatoes to meet their social obligations as community members. In case tomatoes are infected with tospoviruses, such members get less or no money at all thus limiting their expenses as lack resources to enable them buy clothes for example a farmer in busiita said *“without tomato sales I cannot buy a dress to attend most social gatherings. If you put on the same gomesi, you are referred to by that particular attire”* Wearing the same clothes to different ceremonies whether burial or wedding is quite embarrassing and demoralizing as it sometimes has an impact of not being listened to during meetings. This is an effect of tospovirus on farmer’s livelihoods.

Some farmers expressed that failure to sell tomatoes means inability to finances. Farmers have formed SACCOs that enable them to save, borrow and share the collections. These SACCOS through savings have enabled them pay school fees for their children as well as startup businesses and shops. Members that do not get money due to crop failure as a result of tospoviruses become socially deprived as shown by 50% of the respondents interviewed. Farmers whose tomatoes are faced with tospovirus get losses and are unable to pay membership fees for their groups thereby not accessing loans to help them meet other necessities like school fees. This is also an effect of tospoviruses on farmer’s social capital.

Social capital as a livelihood asset is affected in such a way because time for leisure is interfered with as they have to work longer in the gardens infected with the virus. Time to relax is foregone and they miss out on social gatherings where important information is shared yet this would be vital for improving their production levels. Time is spent on

spraying the tomato tospoviruses instead of leisure and enjoying the available social amenities as work without play makes Jack a dull boy.

4.5.6 Tospovirus Effect on Physical Capital

Physical capital makes farmers' livelihoods better as they are able to buy tools for farm use such as hoes, shovels, hand saws, slashers, knives, let alone accessing big equipment like tractors. This is possible if they harvest almost 100% of tomatoes grown and sold at high prices with no incidence of tospoviruses. With the existence of tospoviruses, farmers risk up to 100% losses thereby having no hope of buying farm tools as well as accessing other services in the community. Similar results on losses were reported by Berling et al, 1990.

Things like rural electricity, roads and paraffin cannot be provided in the community. One farmer from kigguli said *"we have power here but I do not use it since I cannot afford to pay since I lost my tomatoes"*. A sub county NAADS coordinator also shared that tomatoes are cash crop that can enable farmers afford to pay electricity bills with absence of diseases. In addition, electricity can be a good source of income as a farmer with income from sale of tomatoes can start a cinema hall commonly known as "Bibanda" to show football and movies as well as earning income from charging mobile phones. Therefore tospoviruses have an effect on livelihoods of the farmers.

Tospoviruses have an effect on farmers' livelihoods because they tend not to access credit from financial institutions. Banks and microfinance institutions need collateral for one to get a loan from them. When farmers sell tomatoes, they are able to buy assets like land and build a house which they can use as security so as to access credit. One farmer from nabatu said *"I get a loan from centenary bank to pay school fees and pay back after selling my crops"*. If

such a person faces a risk of tospovirus then getting a loan becomes difficult thus affecting his wellbeing.

When farmers sell their produce, they are able to pay taxes and in turn the district opens up roads and markets where produce can be sold. These taxes are mainly collected from every farmer during market days by the sub county authority. The taxes collected are meant to maintain the roads enabling accessibility for vehicles to go into villages and buy from the farms. In addition, the roads also become impassable especially in the rainy season as was experienced during the study.

Once farmers have a poor harvest and quality of their tomatoes, then they risk the market not buying or offering very low prices. This way taxes are not paid and farmers go away with minimal income and this limits their access of medical treatment due to lack of money. The farmers lack good roads and transport network for their produce so that they can look for better markets for their tomatoes thus an effect of tospoviruses on farmer's livelihoods.

According to the theory, farmers' livelihoods can best be improved through conducting a one-on-one exchange of information as this helps generate ideas and knowledge on how to maximize incomes.

Livelihoods are multidimensional covering not only economic but political, cultural, social and ecological aspects. Livelihoods also comprises of capabilities, assets and activities.

4.6 Management Practises of Tospoviruses in Tomato by Farmers

Tospoviruses have continued to affect the quality and quantity of tomatoes in Sironko and farmers through their indigenou knowledge have tried to control the disease. Farmers use both traditional and scientific practices. Similar practices were reported by Waiganjo et al., (2006) on use of both cultural and insecticide application, uprooting. Among the

management practices that the farmers shared include intercropping, uprooting, timely planting, spacing for easier weeding of their gardens in order to get good quality fruits as indicated by 79.4% responses.

The farmers also manage tospovirus by harvesting their tomatoes early just before the fruits start ripening and this was a common practice among the farmers interviewed. One of the sub county NAADS co-ordinator shared that *“Farmers see tospoviruses as a problem but majority that observe symptoms on the fruit tend to sell the tomatoes raw and unnoticed.”* On the other hand, the farmers store their tomatoes by spreading them on the floor so that they are aerated to avoid rotting.

The farmers use both traditional and chemical control methods but the use of sprays is a more preferred method of management. One farmer found spraying tomatoes expressed that *“I use diathane to spray my tomatoes because it’s easier to apply within a short time”* The agricultural officer a key informant also indicated that the farmers use both methods. She went further to say *“the traditional method is practiced mainly for small scale production and includes use of ash spread on the leaves, intercrop of tomatoes with garlic as a repellent, use of red chilli pepper soaked in water and applied on the tomato plants, crop rotation and uprooting as well as roguing.”*

“Farmers spray their tomatoes with mainly dithane to control tospoviruses” said Bumasifwa sub county NAADS co-ordinator, one of the key informant interviewed. Other chemicals that are used include *dudu thioties for aphids, dithene for blights and copper for fungicides as well as foliar feed for the leaves* as shared by one of the key informants interviewed during the study. However, majority use sprays as shown by the 87.8% to control the disease because they find it easier. The method used is through the advice of agro-shop dealer that sells the inputs to the farmers and was indicated by 95% as compared to the others.

The farmers through their efforts have tried to control tospoviruses only that all diseases and pests that attack the tomatoes are treated the same. Even if the practices seem to work for the farmers, they are poorly applied for example the farmers said they do timely planting and spacing but this does not control the spread of tospoviruses. Care and attention must start from the nursery bed where tomato seedlings are raised. The nursery bed must also be free of weeds as these are the major hosts of thrips which cause tospoviruses. Weed management is a proper method to control tospoviruses.

The majority of the farmers saw the Chemical method as being the preferred method because the chemicals are easily available and accessed as indicated by 75% respondents. It is a waste to spray tomatoes once they are infected with tospoviruses because they can only be controlled but not cured. It is also important to know when to spray and what rightful chemical to use. Not all chemicals accessed control tospoviruses in tomatoes. It is important to know what chemical to apply on what disease because fungicide sprays may not manage viruses like tospoviruses. It is also important to control the pests that spread the virus so as to reduce the spread.

The farmers do not know that the tospovirus disease starts from the nursery bed to harvesting stage. The land prepared for the production of the tomatoes can already be infected with tospoviruses and even weeds around this land host the thrips which spread tospoviruses and yet farmers only mind about the weeds on this land and ignore those around the garden.

Plate vii: A Tomato Garden with Weeds



Source: Bugitimwa sub county (August 2011)

Farmer's gardens had weeds as a common practice. The farmers do not seem to realize that weeds harbor insect pests which serve as hosts for tospoviruses and also compete for food with the Tomatoes. This may have been due to the fact that the thrips are very small and hide in flowers and below leaves. It is also recommended that infected plants should be removed from a field and destroyed so as to prevent further spread of the disease. This is possible through weeding but usually what farmers do is remove infected plants and leave them in the garden. Regular weed removal forms part of the cultural practices for management of thrips and tospoviruses.

In cases where fields are weedy for a long time, a higher incidence of viruses was found. What farmers also don't know is that once a plant is infected with a virus, no chemical treatments can cure it of the virus however, avoidance is the best management strategy for example weeding the garden as well as other weeds of neighboring gardens to reduce infection. Management of the disease is difficult because the virus has a wide host range which allows the virus to over season from one crop to the next.

Here the best approach to take in order to manage tospoviruses according to the theory of agricultural extension is participatory bottom-up. This way the experts let the farmers identify their management practises which together they can improve upon and devise better control methods.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This chapter looks at the summary of findings, conclusions as well as recommendations of the study on tospoviruses on knowledge, attitudes, effects on livelihoods and management practices.

5.1 Summary of Findings

Poor knowledge on tospoviruses is due to the fact that sources of information are limited yet limitations in knowledge greatly affect total yields and marketable yields in the communities under study. In turn this lack of knowledge limits the buildup of the five livelihood assets.

Poor and mistaken attitudes and perceptions towards the tospoviruses as a dangerous disease transmitted through the wet season according to them further drains the farmers of their limited capital because they buy chemicals to spray a disease which shouldn't be sprayed once plant is infected.

Tospoviruses affect farmers in terms of their livelihood assets like natural, human, financial, social and physical. Tospoviruses affect their access to goods and services to help them educate their children and access medical treatment

Existence of tospovirus affects livelihoods as it compromises the quality of the tomatoes and reduces the incomes earned from sale of tomatoes. Tospovirus affects livelihoods because access to financial services in form of loans from SACCOS, microfinance institutions and banks due to lack of security. Tospoviruses affect human capital as majority lack skills that they would employ to control the tospoviruses. Financial capital is affected by tospoviruses because low yields are realized from the harvests farmers end up with very little to sell thus limited savings an effect on livelihoods.

Management is poor because farmers have poor knowledge about symptoms of how the disease is transmitted for example farmers use fungicides to control viruses.

Farmers use both chemical and traditional management practices where chemical control is for commercial purposes. The chemical management practice is preferred as compared to the traditional method that is not normally used. Spraying is a waste of money which could be used to weed and buy pesticides that could kill thrips that spread tospoviruses.

Farmers are not knowledgeable that nursery beds and gardens should be kept free of weeds at all times because weeds are hosts of thrips which are agents of tospoviruses.

Farmers spray gardens already infected with tospoviruses. This is due to lack of knowledge that once a garden is infected with tospovirus you cannot control it.

5.2 Conclusions

The study focused on farmers' knowledge on tospoviruses and also evaluated farmers' attitudes and perceptions of tospovirus infection as well as effect of tospoviruses on livelihoods and management practices in controlling the tospoviruses in tomatoes. Based on the findings of the study a number of issues were raised and there fore the following conclusions were drawn:

Farmers' socio-economic characteristics have an important role to play in managing tospoviruses in order to improve yields and livelihoods. According to the findings, the gender, education level, marital status and age influence the knowledge, attitudes and perceptions towards tospoviruses.

During the study, it was observed that farmers' knowledge, attitudes and perceptions influence the management of tospoviruses for example farmers who are not knowledgeable

about symptoms of tospoviruses made more losses in yields than those who observed symptoms and managed the tospoviruses early. In addition, farmers are aware of varieties of tomato grown and can differentiate the varieties through attributes that they attach to the different varieties. The study findings on knowledge on varieties show that Cal J/Kamongo is the best and most preferred variety for them.

From findings, it is further concluded that the effects of tospoviruses affects both incomes and household needs because of reduced yields and thus an effect on the market available for the tomatoes.

According to the study findings, it was observed that attitudes by the farmers show that farmers believe that the causes of tospoviruses are: abrupt weather changes, delayed spraying and use of limited volumes of chemicals. Farmers, through their indigenous knowledge and experience, have come up with practices for management of the disease. In conclusion, farmers have poor knowledge, attitudes and perceptions towards tospoviruses as they mistake the virus for different diseases.

Poor management practices of tospoviruses mean poor quality yields harvested thus an impact on the economic empowerment of the farmers as well as limited finances to meet necessities. Tospoviruses also affect the physical capital due to low prices offered for the produce thus having low incomes to but physical assets.

From the study findings, it is concluded that farmers' management practices affect the control method as per the farmers' knowledge, attitude and perceptions towards the tospoviruses. It is also concluded that poor management of tospoviruses is due to poor knowledge, attitudes and

perceptions towards the disease. The option that they take to control the disease is spraying with chemicals yet this is sometimes done at the wrong time when the disease has already affected the tomatoes.

From the study findings, it is concluded that poor knowledge, attitudes and perceptions mean poor management practices and these affect farmers' livelihoods. Lack of knowledge, poor attitudes and perceptions of tospoviruses lead to poor management practices which affect farmer's livelihoods.

5.3 Recommendations

Based on the key finding on knowledge which shows that farmers are , the recommendation is that farmers' need to be sensitized on the occurrence of tospoviruses, its effect as well as proper management practices. This would help in improving on quality as well as yields harvested and incomes for improved livelihoods.

Where as the findings show that there are effects of tospoviruses affect the farmer's incomes and livelihood, farmers need to be sensitized of timely weeding, right chemicals to use for the management of tospoviruses. As a recommendation, there is need for training and sensitization for tomato farmers by NARO, MAAIF, NAADS and other development agencies.

There is also need for strengthening partnership in extension service delivery through public private partnership. In the study, it was seen that organisations like NAADS existed however providing technical advise on pests and diseases lacked. The Agro shops need to be monitored and trained for delivery of advise to farmers as well as provision of genuine chemicals.

Farmers need hands on training and as a recommendation, demonstration gardens can be established as the best means of training in order to change the farmers' attitudes and perceptions towards the disease for better management practices. This can involve weeding, roguing and destroying infected plants to prevent further spread of the disease.

Some of the gaps identified from the study findings, recommended for further research include :

1. Use of demonstration gardens for hands on training and uptake of technologies.
2. The use of public private partnerships in extension service delivery for management of tospoviruses.

REFERENCES

- Aphane Juliet, Chadha & Oluoch Mel (2002): *Increasing the consumption of micronutrient-rich foods through production of indigenous foods*. Food and Agricultural Organization-African Vegetable Research Development C international workshop proceedings, Arusha Tanzania
- Asgarinya, (2010): *Traditional agriculture of farmers because of lack of sufficient knowledge of modern techniques*. IRNA
- Bananej, K., Shahraeen, N., Ahoonmanesh, A., Lesemann, D. E., & Shahriary D, (1998). *Identification of Tomato spotted wilt virus from tomato fields in Varamin area*. (English abstr.) Iran J. Plant Pathol. 34:30-36.
- Banjo, Lawal , Fapojuwo & Songonuga (2003): *Farmers' knowledge and perception of horticultural insect pest problems in southwestern Nigeria*, *African Journal of Biotechnology* Vol. 2 (11), pp. 434-437
- Berling A, Llanas-Bousquet W, Malezieux S & Gebre Selassie K (1990) *Tomato spotted wilt virus. Connaître le problème pour enrayer l'épidémie*. *Phytoma* no. 422, 46-50.
- Black A.W Extension theory and practice: *Australian Journal of Experimental Agriculture* 40 (4) 493 – 502, CSIRO (2000)
- CABI/EPPO (1998) *Tomato spotted wilt tospovirus. Distribution Maps of Quarantine Pests for Europe* no. 342. CAB International, Wallingford (GB).
- Chagunda M G G, Msiska A C M, Wollny C B A, Tchale H & Banda J W (2006) An analysis of smallholder farmers' willingness to adopt dairy performance recording in Malawi. *Livestock Research for Rural Development* (Volume 18, Article #66. 2012, from <http://www.lrrd.org/lrrd18/5/chag18066.htm>
- Chambers, R., Conway, G., (1992). *Sustainable Rural Livelihoods. Concepts for the 21st Century*. IDS Discussion Paper 296. Brighton: The Institute of Development Studies, Sussex, UK.
- Cortêz, I., Livieratos, I. C., Derks, A., Peters, D., & Kormelink, R. (1998).Molecular and serological characterization of Iris yellow spot virus, a new and distinct tospovirus species. *Phytopathology* 88:1276-1282
- Culbreath A. K , Csinos A.S, Bertrand P.F., Demski J.W (1991). : *Tomato spotted wilt virus epidemic in flue-cured tobacco in Georgia*. *Plant dis.* 75, pp 483-485
- Karibwije Daniel & Mugisha Odrek Rwabwogo, Uganda Districts Information Hand book, Expanded Edition, *Fountain publishers*, (2005)
- Decoteau, D.R. (2000) : *Vegetable crops*. Prentice-Hall, inc. USA. 561p.
- Defrancq, M. (1989). Report on Consultancy on Plant Protection in Horticulture, UGA/87/003, FAO/UNDP, 46 pp.

EPPO, 2004: Data sheets on quarantine pests; Tomato spotted wilt tospovirus.(revision of original 1997 data sheet)

EPPO/CABI (1997c): Tomato spotted wilt tospovirus In: Quarantine pests for Europe (2nd ed), pp. 1379-1387. CAB International, Wallingford (GB). Food and Agricultural Organisation 2008, Country report on the state of plant genetic resources, NationalAgricultural Research Organisation, 2nd report

Food and Agriculture Organization (2003): Statistical data bases, Food and Agriculture Organization Statistics, Agriculture, Dry onions. www.fao.org

Gera A. Kritzman A, Cohen J. Raccah, Antignus B.Y. 2000: Tospoviruses infecting vegetable crops in Israel: EPPO bulletin 30, 289-292.

Goldbach R., & Kuo G., (1996). Introduction: *Proceedings of the international symposium on tospovirus and thrips of floral and vegetable crops*. Acta Hortic. 431:21-26.

Goldbach, R., & Peters, D. (1994). Possible causes of the emergence of tospovirus diseases. *Semin. Virol.* 3:113-120.

Golnaraghi, A. R., Pourrahim, R., Shahraeen, N., & Farzadfar, S. (2002). first report of Groundnut bud necrosis virus in Iran. *Plant Dis.* 86:561

Hansen, A. J. (1990). Report on consultancy on fruit trees and vegetables virology.

Hassani-Mehraban, A., Saaijer, J., Peters, D., Goldbach, R., & Kormelink, R. (2005). *A new tomato-infecting tospovirus from Iran*. *Phytopathology* 95:852-858.

Jaw Fen Wang & Chin Hang L (2005), *Integrated management of tomato bacterial wilt* AVRDC, the World vegetable centre.

Jensen Lynn (2003): *Alternative methods for controlling onion thrips- effects of thrips on two varieties of stored red onions*, Oregon state university

Jensen Lynn (1995): Thrips effects on fourteen sweet Spanish onion varieties, Oregon State University, Ontario, Oregon

Jones D.R. (2005): *Plant viruses transmitted by thrips*: *European Journal of plant pathology* 113:119-157

Khalid, A., (2002). *Assessing the long-term impact of IPM Farmer Field Schools on farmers' knowledge, attitudes and practices*. A case study from Gezira Scheme, Sudan. In: *International Learning Workshop on Farmer Filed Schools (FFS): Emerging Issues and Challenges*. Yogyakarta, Indonesia

Kydd Jonathan (2002): *Agriculture and rural livelihoods: Is globalisation opening or blockingpaths out of rural poverty?* Agricultural Research & Extension Network, Network Paper No. 121

Law M. D., & Moyer, J. W. (1990). *A tomato spotted wilt-like virus with a serologically distinct N protein*. *J. Gen. Virol.* 71:933-938.

Lebas, B.S.M, Ochoa-Corona, F.M (2007): *Impatiens necrotic spot virus Characterisation, diagnosis and management of plant viruses*. Vol. 4

Mahantesh, N. & Alka Singh (2009): *A Study on Farmers' Knowledge, Perception and Intensity of Pesticide Use in Vegetable Cultivation in Western Uttar Pradesh*. Division of Agricultural Economics, Indian Agricultural Research Institute, New Delhi - 110 012 *Pusa AgriScience* Vol. 32, 63-69

Makerere University (2007): National Development Plan (2010/11-2014/25), 244, Crop sector: The External Monitoring Unit of Makerere University, department of Agricultural Economics (2007), page 78

Martaamidjaja A.S, & Rikhana M. (1996): Group-based Extension

Mavric, I, Ravniker M. (2001): First report of tomato spotted wilt virus and impatiens necrotic spot virus in Slovenia *plant Dis.* 85: 1288, page 315.

Ministry of Agriculture Animal Industry and Fisheries : Crop Census Report (1998)

Molazadeh, S. (2010): Lack of farmers' knowledge of pesticide spray time is the main problem of pesticide use. IRNA.

Moritz, G., Kuman S. Mound, L. (2004): Tospovirus transmission depends on thrips ontogeny. *Virus res.* 100, pp 143-149

Mukiibi, M. K. (2001). *Agriculture in Uganda Vol. I General Information* 486 pp. Uganda

Mumba C, Samui K L, Pandey G S, Hang'ombe B M, Simuunza M, Tembo G and Muliokela SW (2011) *Economic analysis of the viability of smallholder dairy farming in Zambia*. *Livestock Research for Rural Development*. Volume 23, Article #137. Retrieved March 6, 2012

Mwaule, Y. W. (1995). Draft Report of the Consultancy on Tomato Research results in Uganda from 1980 -1995, GTZ -IPM Horticulture Reports. 85 pp.

National Agricultural Research Organization report (1999)

National Development Plan 2010/2015, Growth employment and socio economic transformation for prosperity, (2010)

Nono-Womdim, R., Swai, I. S., Green, S. K., Gebre-Selassie, K., Laterrot, H., Marchoux, G., and Opena, R. T. (1996). *Tomato viruses in Tanzania: identification, distribution and disease incidence*. *J.S.Afri.Soc. Hort. Sci.* pp. 41 - 44.

Obopile M., Munthali D.C & Matilo B. 2008: *Farmers' knowledge, perceptions and management of vegetable pests and diseases in Botswana*, Science direct, Crop Protection, Volume 27, Issue 8, (2008)

Okali C. & J.E Sumberg (1986): Examining divergent strategies in farming systems research *Agricultural administration*, 22(4)

Otieno D.C.I, Odhiambo D.M & Mairura M.O (2009) *Economics evaluation of relative profitability in small hold dairy farms in Western Kenya*. *Journal of Development and Agricultural Economics*. Volume 1, Article #2, pp 49-54.

Peters D., Wiljkamp I., Van de Wetering F., Goldbach R. (1996): Vector relations in the transmission and epidemiology of tospoviruses, *Acta hort*, 431, pp 29-43

Population and Housing Census, Sironko district report, (2002)

Prins, M & Goldbach R. (1998): The emerging problem of tospovirus, infection and non-conventional methods of control. *Trends in microbiol.* 6, pp31-35

Programmes for Natural Resource Conservation in Java: Food and Agricultural Organization (1996).

Reddy, D. V. R., Sudarshana, M. R., Ratna, A. S., Reddy, A. S., Amin, P. W., Kumar, I. K., & Murthy, A. K. (1991). *The occurrence of yellow spot virus, a member of tomato spotted wilt virus group, on peanut (Arachis hypogea L.) in India.* Pages 77-88 in: *Virus-Thrips-Plant Interactions of Tomato spotted wilt virus.* H. T. Hsu and R. H. Lawson, eds. Proc. USDA Agric. Res. Serv., ARS-87.

Rodriguez DR (1990) *Frankliniella occidentalis in protected cultivation in Almería India:1st Symposium on Frankliniella occidentalis.* Valencia (ES) (in Spanish).

Rybicki & Pietersen (1999): *Plant virus disease problems in the developing world.* Advances in Virus Research, Vol.53: 128-175.

Sarantakos Sotirios (1997): *Social research* Palgrave publishers ltd, Houndmills, Basingstoke, Hampshire RG21 6XS

Scott Adkins (USDA-ARS, Fort Pierce, FL), Tom Zitter (Department of Plant Pathology, Cornell University, Ithaca, NY) & Tim Momol (Department of Plant Pathology, NFREC, IFAS, University of Florida, Quincy, FL). (2012) Tospoviruses National Pest Alert.

Shahraeen, N., Ghotbi, T., & Mehraban, A. H. (2002). Occurrence of Impatiens necrotic spot virus in ornamentals in Mahallat and Tehran provinces in Iran. *Plant Dis.* 86:694.

Sonko Robinah, Evelyn Njue, James M. Ssebuliba & Andre de Jager (2005): Pro poor Horticulture in East and South East Asia, Horticulture in Uganda

Uganda Bureau of Statistics (2010): Statistical abstract

Valera A.M (1995): Thrips damage on tomato, ICIPE, Nairobi, Kenya

Van Regenmortel, M. H. V., Fauquet, C. M., Bishop, D. H. L., Carstens, E. B., Estes, M. K., Lemon, S. M., Maniloff, J., Mayo, M. A., McGeoch, D. J., Pringle, C. R. & Wickner, R. B. (2000). *Virus taxonomy.* Pages 599-621 in: *Seventh Report of the ICTV.* Academic Press, New York.

Waiganjo, Wabule, Nyongesa, Kibaki, Onyango, Wepukhulu, & muthoka (2006): Tomato production in kirinyaga district, kenya, a baseline survey report

Wangai A.W., Mandal , Pappu & Kilonzo (2001): Outbreak of Tomato spotted wilt virus in tomato in Kenya. *Plant Dis.* 85, 1123

Yudelman, Ratta & Nygaard, (1998) : *Pest management and food production: looking to the future*: (Food agriculture and the environment discussion paper 25). International Food Policy Research Institute.

APPENDICES

Appendix 1: Data Collection Tools

APPENDICES

Appendix 1: Data Collection Tools

APPENDIX I: SEMI- STRUCTURED QUESTIONNAIRE FOR FARMER

Dear Sir/Madam,

I am Nabuzale Rita pursuing Master of Arts degree in Rural Development, Department of Sociology, Faculty of Social Sciences, Makerere University. I am carrying out this study as an academic fulfillment of the requirements for the award of a Master Degree in Rural Development. The main objective of the study is to understand the impact of tospoviruses tomatoes, and well-being of the farmer and how you control the tospoviruses. You have been randomly selected among farmers of tomato to participate in the study to understand farmers' knowledge, attitudes and tospovirus infection management practices of tomatoes in Sironko district. Your responses will be used for research purposes only and will be anonymous and confidential.

Date/Time.....

SOCIO-ECONOMIC BACKGROUND

LOCATION:

1.1 Subcounty

1.2 Parish.....

1.3 Village

Respondents Information

1.4 Respondent's name (optional).....

1.5 Gender 1. Female 2. Male

1.6 Respondent's Age (in years).....

1.7 Respondent's ethnicity.....

1.8 Marital status

1.9 Position of respondent in the household: 1. Husband 2. Wife 3. Father 4. Mother 5. Daughter 6. Son 7. Worker Others specify.....

1.10 a) Management of family resources.

Who	Husband	Wife	Children	Others specify
Owns land				
Has access to land				
Controls land				
Provides labour				
Provides capital				

1.9 i) What is your main occupation?.....

1.9 ii) Do you have any other occupation?.....

1.10a) Have you attended school? 1- Yes 2- No

1.10b) If yes, what is your highest level of formal education attended?

1. Nursery 2. Primary 3. Secondary 4. Tertiary 5. None 6. Others specify.....

1.11 a) How many members are in the household?.....

1.11b) List them in the table below

Name of H/H members	Sex	Age	Education level
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			

SECTION B: FARMERS' KNOWLEDGE, ATTITUDES AND PERCEPTIONS ON TOSPOVIRUSES

2. 1a) What are the main crops that you grow on your land?

Crop grown	Land under cultivation (acres)	Source of labour	Rank as food crop	Rank as cash crop

2.8 How are tospoviruses spread?

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

2.9a) Does the tospovirus affect other crops as well?.....

2.9b) List the crops below.....

.....
.....

SECTION C: EFFECT OF TOSPOVIRUSES ON LIVELIHOODS

3.1i) What effects do the tospoviruses have on the yields of

Tomatoes.....
.....
.....

3.1 ii) What effects do the tospoviruses have on:

a) The labour up take in relation to other

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

b) The household necessities?

.....

c) Others.....

.....

3.3a) Do the tospoviruses affect the marketing of tomatoes? 1. Yes 2. No

3.3 b) What is your market for tomatoes?

Vegetable	Quantity	Price	Buyer/location
Tomatoes			

3.4i) Does the market require you to sort and grade the tomatoes

.....

APPENDIX II: INTERVIEW GUIDE FOR KEY INFORMANTS

Topic: *Farmer's knowledge, attitudes and tospovirus infection management practices in tomato in sironko district*

Dear Sir/Madam,

I am Nabuzale Rita pursuing Master of Arts degree in Rural Development, Department of Sociology, Faculty of Social Sciences, Makerere University. I am carrying out this study as an academic fulfillment of the requirements for the award of a Master Degree in Rural Development. The main objective of the study is to understand the impact of tospoviruses in tomatoes, and well-being of the farmer and how you control the tospoviruses. You have been randomly selected among farmers of tomato to participate in the study to understand farmers' knowledge, perceptions and tospovirus infection management practices in tomatoes in Sironko district. Your responses will be used for research purposes only and will be anonymous and confidential.

1. What tomato varieties are grown in the area?
2. Are the tomatoes grown for food or cash crop?
3. What are the challenges that farmers face in the production of tomatoes?
4. What pests and diseases affect tomatoes as perceived by the farmers?
5. Have the farmers heard about tospoviruses in tomatoes?
6. What are farmers' perceptions about tospoviruses?
7. Do the farmers know how tospoviruses look like in tomatoes?
8. Have the farmers attended any training on tospoviruses in tomatoes?
9. What kind of training have they attended?
10. Do farmers know that tospoviruses affect other crops as well? List the crops
11. Do farmers know the effect of tospoviruses in tomatoes?
12. What impact does the above effect have on:
 - Family income
 - Farmers' livelihoods
13. How do farmers manage tospoviruses in tomatoes?
14. Are there alternative control measures for tospoviruses?
15. Is there anything else you feel is relevant and has been left out?
16. What do you think would be the best way of controlling tospoviruses that farmers could adopt?

APPENDIX III: INTERVIEW GUIDE FOR FOCUS GROUP DISCUSSION

Topic: Farmers knowledge, perceptions and tospovirus infection management practices in tomatoes in Sironko district

Dear Sir/Madam,

I am Nabuzale Rita pursuing Master of Arts degree in Rural Development, Makerere University, Faculty of Social sciences (Department of Sociology) You have been selected to participate in the study on "farmer's knowledge, attitudes and management practices on the impact of tospovirus infection on tomato production and livelihoods in Sironko district." I am conducting this study as an academic fulfillment of the requirements for the award of a Master Degree in Rural Development. This study has the objective of understanding farmers' knowledge, perceptions and tospovirus infection management practices in tomatoes in Sironko district. Kindly contribute generously to the study by answering the following questions as all responses will be used for research purposes only and will be anonymous and confidential. Is it ok if we proceed?

1. What crops do you grow? Give reasons for choice
2. Rank the crops grown above from the top most important.
3. How much land is allocated to the production of :
- Tomatoes
4. What varieties of tomatoes do you grow? Give reasons for choice of variety.
5. Do you face any problems in the production of tomatoes?
6. What pests and diseases affect tomatoes?
7. Have you heard of tospoviruses?
8. What do you perceive of tospoviruses?
9. In your perception, can you describe how a tomato or onion plant affected by tospoviruses looks like?
10. Are there any other crops that are attacked by tospoviruses?
11. Have you had any training in tomato production?
12. What kind of training
13. Do tospoviruses affect yields of tomatoes?
14. Do you sort and grade your tomatoes for the market?
15. Does infection of tospoviruses in tomatoes affect sorting and grading process?

16. Do the tospoviruses affect the market what market?

17. What effects do the tospoviruses have on

- Prices offered and incomes
- Household necessities
- Livelihoods

18. How do you control the tospoviruses in tomatoes?

19. Have you accessed any other kind of control measures?

20. What was the source of information?

21. What else would you like to share that might have been left out during the discussion?

22. Make any suggestions on the measures that can be used in the management of tospoviruses?

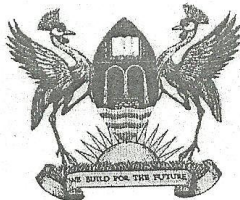
Thank you for your time

Appendix 2: Introductory letter

Appendix 2: Introductory letter

MAKERERE

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DEPARTMENT OF SOCIOLOGY AND ANTHROPOLOGY

Monday, 06 June 2011

The Chief Administrative Officer
Sironko District Local Administration
Sironko

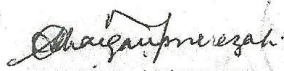
Dear Sir/Madam,

Re: **Ms. Rita NABUZALE (2009/HD14/15815U): Introduction**

This is to introduce **Ms. Nabuzale**, a registered postgraduate student in the Department of Sociology, Faculty of Social Sciences, Makerere University. Ms. Nabuzale is carrying out a study on "**Farmers' Knowledge, Attitudes and Management Practices of Tomato Tospovirus Infection in Sironko District**". She is doing this study in partial fulfilment of the requirements for the award of the Master of Arts degree in Rural Development of Makerere University.

The study results are expected to be valuable to agricultural extension departments and organisations especially the District Production offices and the National Agricultural Advisory Services (NAADS) programme. As her supervisor, I would therefore appreciate any form of assistance that can be given to her especially in terms of accessibility to important and relevant information and respondents.

Yours truly,


Dr. Peter R. Atekyereza,
Assoc. Professor and Supervisor



cc: The LCV Chairperson
The Resident District Commissioner
The District Security Officer
The Production officer

Map 2: Map of Sironko District

