INDRA GANDHI NATIONAL OPEN UNIVERSITY

SCHOOL OF CONTINUING EDUCATIO

PROBLEMS AND PROSPECT OF POTATO PRODUCTION AND MARKETING

A CASE STUDY ON SNNPR GAMOGOFA ZONE CHENCHA WOREDA GENDOGEMBELA AND DOKO YOYERA RURAL KEBELE

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A THESIS SUBMITTED IN PARTIAL FULFILLMENT FOR M.A IN RURAL DEVELOPMENT

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I DECLARATION

(STATEMENT OF THE AUTHOR)

I hereby declare that the Dissertation entitled PROBLEMS AND PROSPECT OF POTATO PRODUCTION AND MARKETING A CASE STUDY ON SNNPR GAMOGOFA ZONE CHENCHA DISTRICT submitted by me for the partial fulfillment of the master in Rural Development to Indira Gandhi Open University, (IGOU) New Delhi is my own original work and has not been submitted earlier either to IGNOU or to any other institution for the fulfillment of the requirement for any course of study and the award of any academic degree, diploma, or certificate. I also confidently declare that no chapter of this manuscript in whole or in part is lifted and incorporated in this report from any earlier work done by me or others.

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II CERTIFICATE

This is to certify that Mr Seifu Abite Student of Master of Art in Rural Development from Indira Gandhi National Open University, New Delhi was working under my supervision and guidance for his Project Work for the course MRDP – 001. His Project Work entitled PROBLEMS AND PROSPECT OF POTATO PRODUCTION AND MARKETING A CASE STUDY ON SNNPR GAMOGOFA ZONE CHENCHA DISTRICT which is submitting , is his genuine and original work.

Place ---------- *Signature----------*

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IV ACRONYMS / ABBREVIATION

- *Belg : January up to June*
- *CIP: International Potato Seed Center*
- *CSA: Central Statistical Authority*
- *DLS: Diffused Light Store*
- *FGD: Focus Group Discussion*
- *Ha: Hectare*
- *Kg: Kilogram*
- *M : Meter*
- *Meher : July up to December*
- *MOA: Ministry Of Agriculture*
- *SNNPR: Southern Nations Nationalities and Peoples Region*
- *TPS: True potato seed*
- *t: Ton*
- *SSA: Sub Saharan African Countries*
- *Qd: quantity demand*
- *Qs: quantity supply*
- *QDPM: Quality Declared Planting Material*
- *MOA ministry of agriculture*
- *PVY: Potato Y virus*
- *PVM: potato mosaic virus*

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V ABSTRACT

This research was carried out with an aim to conduct and explore the study on major problems and prospect of potato production and marketing activities by taking Gendo gemebela and Doko yoyera rural kebeles as a case study in chencha district Gamogofa Zone SNNPR southern Ethiopia. It entails the specific objectives of examine the production, consumption and productivity of potato, evaluate the performance of smallholder farmers potato farming practice based on modern techniques, identify and analyze the major problems / constraints / that hinder the development of potato farming, explore the contribution of potato production towards food security and income of the smallholder farmers, assess potato value chain analysis, investigate the role of rural women's in potato production, and to suggest strategic intervention area and action to be taken as a solution in the study area. Primary data have been be collected from 100 selected respondent /farmers/ this supplemented by information from two focus group, & 20 key informants and also retrieved from relevant report and documents. The result of the study shows that production and productivity on seed potato got the highest yield and benefit to multipliers but the ware potato producer couldn't achieve these result and benefit so all necessary potato technology should disseminate extensively in the study area. The major problems that hinder the development of potato development and value chain were lack of sufficient quality seed, lack of storage and market, disease and pest intensification, low demand, and poor integration between main stakeholders. So this problem should be solved in order to benefit the producers. The result also indicate that the main actors in potato value chain should embraced in the development strategies, the techniques that modern potato farming practice should be disseminated in the study area , if we really to achieve highly the contribution of potato that is a buried treasure, food security and sustainable income for the potato producers. Generally the result showed as that the Potato is an important crop for smallholder farmers in chencha, serving as both a cash and food security crop. Based on the study result and problem encountered in potato production and marketing system in the study area, the following recommendation are suggested: establish and or strengthen cooperative, group, individual, FTC that engage in potato seed production to achieve the economies of scale needed to meet ware potato producer high demand for improved potato seed. Thus Improved potato seed replacement system should be put in place by involving the relevant stakeholders (MOA, NGOs, and Research institution and seed producers). The system should enable farmers to replace the improved Variety at regular interval, Applying quality assurance techniques as the required time (from sit selection to post harvest handling practices), Apply cost sharing method on the construction of DLS and ware house at household level, Potato specific technical recommendations should be adequately disseminated (site selection, ploughing, spacing, weeding, fertilisers, post harvest technologies) to increase potato production and productivity, Establish and strengthen potato producer cooperative union at chencha district level to facilitates potato marketing

CHAPTER ONE

1. INTRODUCTION

1.1 BACKGROUND

The potato (Solanum tuberosum) is originated from South America, most probably from the central Andes in Peru. It has been grown by indigenous farming communities since its demonstration over 4,000 years ago. Introduced into Europe in the sixteenth century, the crop subsequently was distributed throughout the world, including Asia in the 19th century (smith, 1995), and into Africa, around the turn of 20th century. It was Also it was introduced into Ethiopia around the same century by German botanist Schimper.

Worldwide, the potato comes fourth in terms of production after wheat, maize, and rice. In many countries potato serves as a staple food because of its excellent nutritional content, specifically carbohydrate. Generally total world potato production is about 284,471 thousand tons per year [2007]. Average yields in SSA[sub sharan African] and Africa are only about 8 t/ha, as compared to world leading producers including the Netherland which is about 40-50 t/ha.

The area occupied by potato in Ethiopia is currently estimated to be about 160000 hectares [Endale, et al 2008]. Several studies indicated that most of the rural area of Ethiopia are suitable for growing potato. Most important is its short duration which is about 3 to 4 months is an opportunity for rural community to use it as a source of food and income. However , its production in the rural community is very much limited and as a result its contribution to ensure food security is hampered by several factors, which include:- A)Technical problems: Lack of sufficient quantity of good quality seed tubers ,lack of appropriate cultivars, sub-optimal agronomic techniques, lack of storage facilities for both ware and seed tubers, shortage of skilled manpower and facilities, limited knowledge on nutritional value developed cultivars and lack of processing industries. B) Natural limitations: Drought and erratic RF, high temperature and frost and high disease and insect pressure and related to economic (market) limitations: High transaction and handling costs, Low and fluctuating prices and Absence of organized marketing systems.

Several developing countries including Ethiopia are making a considerable effort to overcome their respective constraints and use potato as a means to insure food security and their by improve the livelihood of the people.

1.2. STATEMENT OF THE PROBLEM

Potatoes are a source of both food and cash income in the densely populated highlands of Ethiopia. Through this double purpose, the potato crop can play an important role in the rural livelihood system. Because of high prospects for growth of the market for fresh potatoes, this crop could be a good starting point to assist the rural development activities in Ethiopia, particularly under current conditions of increased cereal prices in the markets. Despite the great opportunities that Ethiopia has, which includes suitable edaphic and climate condition for the production of high quality seed and ware potato , and also suitable altitude that ranges between 1800 – 2500 m (Solomon , 1987 as cited in Tasew 2008), there is a great gap between supply and demand for potato. Also, the income from potato to the smallholder farmers is not as anticipated, mainly because of problems of seed potato quality management, bacterial wilt control, late blight control, soil fertility management and marketing problems. Such situation is particularly visible in Southern Nation, Nationalities and Peoples region (SNNPR). Potato believed by many in this region as a source of food and income for more than 15 million rural people (about 90%), of which 49.7% are male and 50.3% female. From the total population in the region about 430,000 people reported to be engaged on about 14000 ha producing over 97,000 tones with an average yield of about 8 ton per hectare, similar to the national average (CSA,2002). A lot of research work have been done and conducted related to potato production and marketing at aggregate level (National & regional level) specifically on the technical aspect but none of them were investigated at district and rural village (chencha district, gendogembela and doko yoyira rural keble) level. There is a strong need to conduct research work at local level to investigate problems that hinder the development of potato productivity, production and marketing, and also its prospect.

1.3. RESEARCH QUESTIONS

What are the major constraints that hinder the development of potato production and marketing??

What are the contributions of potato farming towards the development of livelihood of the smallholder farmers???

Is potato is a buried treasure to the farmers or a good for nothing???

1.4 HYPOTHESIS

- *Potato farming played great role on food security and increases income of smallholder farmers in the study areas*
- *Cultivating potatoes is a good for nothing activities*

1.5 OBJECTIVES OF THE STUDY

1.5.1 GENERAL OBJECTIVES

The general objective of the study is to investigate the problems and prospect of potatoes farming towards smallholder farmer's development in Chencha District gendo gembella and doko yoyira rural kebele.

1.5.2 SPECFIC OBJECTIVES

- To examine the trend of production, consumption and productivity of potato in the study area.

- To evaluate the performance of smallholder farmers potato farming practice based on modern techniques [Assessing and examining of potato technological innovation]

-To identify and analyze the major problems / constraints / that hinder the development of modern potato farming.

-To explore the contribution of potato production towards food security ,and income of the farmer, in the study area.

-To assess potato value chain analysis and development and to identify strategic intervention area and action to be taken.

-To investigate the role of rural women's in potato production and marketing

- To assess and evaluate the role of stakeholders on the development of potato production, productivity and marketing.

1.6 SIGNIFICANCE OF THE STUDY

The significance of the study or it relevance is the following:-

- *To provide valuable information related to potato production, consumption marketing and the challenges on potato farming To Whom It May Concern*

- *To alert the decision makers on solving critical problems*

- *There is no detail local investigation before about the proposed study so there is strong need for local investigation*

- *Used as a spring board for future planning monitoring and evaluation of the potato farming practice*

- *Give insights for students and researcher who interested to study in this topic for further investigation.*

1.6 SCOPE OF THE STUDY

The study focuses on problems and prospect of potato farming practice in Gendo gemebela and Doko yoyera rural kebeles as a case study. It also investigates the role and contribution of potato farming towards food securities and income of smallholder farmers. The study has tried to examine the cultivation practice of the farmers and analyze the major problems and suggest possible solution.

CHAPTER TWO

2. LITERATURE REVIEW

2.1 General Concept and Definition

The potato (Solanum tuberosum) originated from South America, most probably from the central Andes in Peru. The potato has been grown by indigenous farming communities since its demonstration over 4,000 years ago. Introduced into Europe in the sixteenth century, the crop subsequently was distributed throughout the world, including Asia (smith, 1995). It was introduced to most parts of SSA in the 19 century.

Worldwide, the potato comes forth in terms of production after wheat, maize, and rice. In many countries potato serves as a stable food because of its excellent nutritional content. Potato production trend have shown that it is one of the fastest growing crops in SSA in relation to area coverage, but without a corresponding increase in productivity. Average yields in SSA are only about 8 t/ha, compared to a yield potential of about 40-50 t/ha. Potato arrived late in Africa, around the turn of the 20^{th} century. In recent decades, production has been in continual expansion, rising from 2 million tonnes in 1960 to a record 16.7 million tonnes in 2007. Potatoes are grown under a wide range conditions- from irrigated commercial farms in Egypt and south Africa to intensively cultivated tropical highland zones of Eastern and Central Africa, where it is mainly a small farmer's crop. For sub-Saharan Africa, Scott et (2000) projected a 250% increase in demand for potatoes between 1993 and 2020, with an annual growth in demand of 3.1%. The growth in area under production is estimated at 1.25% a year, the rest of the increase being achieved through predicted growth in productivity. Improved of the potato production system in sub-Saharan Africa (SSA), where potatoes an important cash and food crop, can be a pathway out of poverty. The potato has a short cropping cycle (<90 days), and a large area and per time production. It provides more nutrious food per land unit in less Time and often under more adverse condition than other food crops due to its efficient use of water. It is one of the most efficient crops in converting natural resources, labour, and capital into a high quality food. Potato is the small holder cash Crop of the future for the densely populated East and Central African highlands, with a high potential to raising their livelihoods. Furthermore, potatoes provide a cheap but nutritionally rich staple food required in the fast growing cities of contributing protein, vitamin C, zinc and iron to the diet.

For low-income people in both rural and urban areas "potato is a buried treasure "(FAO 2006).

2.2 IMPORTANT OF POTATO AS A POTENTIAL FOOD SECURITY CROP

The potato has a short cropping cycle (< 90 days), and a large per area and per time production. It provides more nutritious food per land unit in less time and often under more adverse condition than other food crops due to its efficient of water. It is one of the most efficient crops in converting natural recourses, labor. and capital into a high quality food. Potato is a smallholder cash crop of the future for the densely populated East and central African highlands, with a high potentials to raising their livelihoods. Furthermore, potatoes provide a cheap but nutritionally rich staple food required in the fast growing cities of Africa, contributing protein, zinc, and iron to the diet. For low income people in both rural and urban areas "Potato is a buried treasure" (FAO 2006)

Potato is grown in highly populated area, intensively cultivated (95%) high, mid, low elevation and it is superior to most food crops in calorie production / hectare

2.3 World production and Main potato production zone

Table 2.1 World production of potato crop

No	***Countries***	***Amount produced thousand tons per year***
1	Indonesia	10125
2	Jordan	3400
3	Chill	2149
4	Ecuador	2066
5	Uruguay	1700
6	Bolivia	1694
7	Egypt	977
	Total world production	284,471

Broadly speaking, there are three major potato systems in Africa;

1. in the densely populated, high-potential areas (1,800-2,750 m) of eastern and central Africa, potatoes are grown by small farmers (0.5-2 ha) both for the market and for home consumption. Yields vary between 5 and 20/ha, with a of mean 8-10 t/ha. Rates for chemical fertilizers and fungicide use vary widely among countries and production areas, but are generally low because farmers cannot afford chemical and supplies are unreliable. Is obtained primarily from informal, local sources and average seed quality is low. Late blight and bacterial wilt, as well as viruses, cause chronic, significant yield losses.

2 In southern Africa, particularly in south Africa, potatoes are grown on a relatively large scale in the modern farming sector. Irrigation is becoming more important, good-quality seed is available, inputs are used intensively, and average yields are high-from 5to over 25t/ha in south Africa.

3. In Cameroon and Nigeria, potatoes are an important small holder crop in higher altitude areas. Elsewhere in West Africa, the is grown on a very small scale as a high- value vegetable, usually under irrigation (FAO, 2010).

Main constraints of potato farming in sub-Saharan Africa are farmers' lack of healthy seed, and attack by late blight, bacterial wilt, viruses, and potato tuber moth. Other important constraints for farmers include leaf miner fly, weeds, unfavourable weather, low soil fertility, inadequate post harvest management and marketing.

2.4 Potato plant growth and development

2.4.1 The potato plant (Ian MacDonald and John Low, Evan Brothers Limited)

The potato consists of the following parts: leaves, stem, roots, tuber, and stolons. Some potato varieties planted in conducive environments can produce flowers and berries that have many small seed, the true potato seed. The function of each of these plant parts are as follows:

Leaves produce plant food (starch and sugar) from carbon dioxide and water using energy from the sun in a process called photosynthesis.

Stems provide support for the above ground plant parts and have vessels for translocation of food prepared in the leaves, water and nutrients.

Root absorbs nutrients from the soil and provide anchor

Tubers are receptacles for storing nutrients and are also the edible part.

Stolons are underground stems on which tubers are born. If they are exposed to sunlight, they become areal stems.

Berries are fruits of the potato just like tomatoes are fruit of tomato plant.

In a process called photosynthesis plants use energy from the sun to change carbon dioxide and water into starches and sugars. These starches and sugar are the plant's food.

2.4.2 Potato Plant Growth (Ian MacDonald and John Low, Evan Brothers Limited)

There are no fixed development stages in potatoes as these are influenced by varieties, shoot size, soil fertility, weather etc. Unlike cereals, potato development stages overlap with each other making it difficult to distinguish between stages. For example sometimes during the early growth stage, developing tubers have already begun to grow from the roots. Nevertheless, a division of potato growth stages can provide a picture of crop's critical development periods. This knowledge is extremely important for developing management strategies. Potatoes planted from seed have the following stages:

Sprout development stage: *this stage begins with several eyes sprouting when the tuber is in storage, continues through planting and up until shoot emerges from the surface of the soil. the time involved for the shoots to emerge from the ground varies greatly depending on the length o the shoot, moisture in the soil and other environmental conditions. With a sprout at the ideal length of 1-2cm, shoots should begin emerging from the ground at around 21-30 days after planting (DAP). During this stage the plant still uses nutrient reserves stored in the tuber.*

Vegetative growth stage: *This stage shows rapid growth of leaves, stems, new shoots and roots. The plant still relies on food reserves stored in* ***the*** *seed tuber, but has already begun to take small quantities of nutrients from the soil. With the most varieties this stage generally occurs between 30-50 DAP. Flowers*

Tuber initiation stages*: although tuber- forming roots begin to form during the vegetative stage, formation of actual tubers only occurs at 40-55 DAP. This stage takes place a relatively short period of about 10-15 days and usually occurs parallel to the onset of flowers. Tubers formed after 65 DAP will not reach optimum size when harvested. Plants require nutrients in large quantities during these stages.*

Tuber bulking stage: *at this stage the plant itself has already stopped growing, and only the tubers become any large. Depending on earliness and tuber bulking behavior of the variety, this stage occurs at 50-100 DAP.*

Tuber maturation stages: *yellowing leaves and dropping stems characterize this stage. Tuber skin gradually hardens and do not pare away easily. Tubers harden due to their increase starch content. This stage occurs at 70-90, 90-100 and 110-130 DAP with early, medium and late maturing varieties, because tubers will have reached maximum maturity signified by their hardiness and sturdy skins.*

Potato growth stages and vulnerability to disease and pest (Ian MacDonald and John Low, Evan Brothers Limited)

At each growth stage plants are vulnerable to certain pests and diseases. The critical time for a potato plant is during the vegetative growth and tuber formation stage. Sever pest and disease infestation during these stages can reduce yield and can even cause crops to fail. Experience from highland areas in Ethiopia shows leaf wilt infection at 30-45 DAP, along with high level of rainfall and humidity , causes plants to die before forming tubers. Appropriate plant management, pest and diseases control during the critical growth stages will support successful potato cultivation.

Table 2.2 Potato pest and disease calendar

Days after planting	*20*	*30*	*40*	*50*	*60*	*70*	*80*	*90*	*100*	*120*
ARTHROPOD PEST (why in upper case)										
Leaf miner fly										
Potato tuber moth										
Aphid										
Thrips										
Cutworm										
White grub										
Mole cricket										
Armyworm										
Looping caterpillar										
Whitefly										
Mite										
DISEASES										
Late blight										
Bacterial wilt										
Virus										

Soft rot										
Common scab										
Early blight										
Dry rot										
Nematode										

Legend

Commonly found are harmful

Rarely found are not harmful

Weather condition plays an important part in disease development. Most diseases are more sever in wet season; however, a few type of root rots are most sever under dry condition. Very favourable condition for disease development may cause a disease that is a low risk to become a high risk. Conversely, high risk diseases may not materialize if condition is unfavourable for disease development. The disease problems occurring on at least the previous four crops should be taken into consideration when planning a crop rotation. Continuous planting to the same crop can eventually cause that low risk disease problems will build up resulting and in severe crop losses.

2.5 Seed preparation and production

2.5.1 Seed tubers and True potato seed

Farmers generally use seed tubers to plant a new crop. However, there is an alternative

Known as True potato seed (TPS), which is the botanical seed of the potato plant. TPS is already in use in several potato producing countries, including India, Vietnam and Indonesia. TPS is not used in Ethiopia to a number of drawbacks.

Table 2.3 Advantages and disadvantages of potato tuber seed versus True potato seed

	Tuber seed	***True potato seed***
Advantages	*Planting technique is relatively easy and familiar to farmers* *Seed tuber generally originate from local crops and are adapted to prevailing conditions* *Plants and tubers produced are the same as parent plants* *Crop growth duration is relatively short* *Seed planted are already sprouting so there is a high likelihood they will grow quickly* *Production is stable when seed are selected properly*	*Small quantity of seed required 120 g/ha, meaning seed cost is relatively low* *Can be sown when needed seeds can be stored for long period of time. When farmers need them, they can be immediately germinated. Germination takes 21 days* *Free from viruses and nematodes* *High production potentials* *Storage and transport costs are relatively low*
Disadvantages	*Difficult for farmers to obtain quality seed. many of the seeds produced by farmers are infected with viruses, nematodes and potato tuber moth larvae* *Seeds need to be stored for a long time (3-4 months) before they are ready for planting* *Seed storage and transportation is relatively expensive*	*Cultivation is complicated and requires a lot of attention, particularly during germination. Specific training is recommended* *Cultivation take more than 120 days* *Some plants and tubers display unusual characteristics*

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2.5.2 Seed generation

We often hear farmers using the times G1, G2, G3, etc., for potato seed. Farmer's conceder G1 potato to be better than G2, G2 better than G3, and so on. But what does G actually mean?

G stands for generation. G1 means generation 1, which is the original parenting stock from botanical seed (true potato seed- TPS) or tissue culture derived in-vitro plantlets. The seed produced by planting G1 seed is referred to as generation 2 seed (G2) and so on. A more important factor that generation is the necessity for using health seed, which to a certain extent is related to generation; this Tropic will be discussed in more detail in section 4.4

Some people think that seed generation influences production characteristics. However, a seed potato not originated from true potato seed will have the same

characteristics as its parent stock, as no hybridization takes place. In the production process, however, plants can get infected by viruses, which are passed on to the next generation in seed tubers, as well.

Criteria for Healthy seed

The seed Tubers produced by farmers usually originate either from plants they have farmed themselves, from other farmers, of other seed producers, General criteria for Health seed are:

Seed must originate from health parents stock; and be free from disease, particularly bacterial will and viruses.

Seed bearing plants should be more than 100 days old at the time of harvest.

Tubers for seed should not be damaged by pests for improper harvest and post-harvest handling. Damaged tubers are more susceptible to disease that influences growth.

Tuber size is not a criterion for health seed; however it is best to use seeds of uniform size, weighing between 40-60 grams/tuber. Seeds for this size are large enough to provide the nutrients potato plants need during the early stages of growth, and not too large a volume of seeds will be required per hectare.

Tuber skins appear fresh and not wrinkled.

Uniform sprout size of around 1-2 cm. uniform sprout will produce uniform growth and make it easier to manage pests and disease. Shorter sprouts will mean plants take longer to emerge from the ground and extend the plants critical period. Sprouts that are too long will make transporting and planting difficult as they are prone to snap easily.

Robust sprouts with bluish colored bases.

Seed selection

2.5.2.1Positive and negative selection of parent stock

Selecting plants for seed is the key to getting healthy seed. There are two methods of selection: positive and negative selection. Both of these are done by making

plants with stock markers. Positive selection is selecting and marking potato plant as parent stock. Plants chosen must display good growth and most importantly should show no sign of bacterial wilt and/or viruses. Negative selection is selecting plants that will not be used as parent stock. Plants marked are those infected with bacteria wilt and/or viruses

Follow selection with a harvesting strategy as follows:

Removing plant foliage – plants are pruned at 80 DAP and all foliage is removed. This is to prevent pests and diseases from moving in to tubers.

If you use positive selection, then you should harvest the selected parent stock before harvesting potatoes for consumption or sale.

If negative selection is used, pull the marked plants and four plants to the left and right of them before harvesting the remaining plants. Only tubers from unmarked plants are used for seed.

2.5.2.2 Sorting seed tubers

Seed tubers need to be sorted at harvest time, during storage and before planting. The objectives of sorting are to:

Remove sources of pests and diseases that can damage that seed potatoes.

Stop pests and disease spreading from one seed tuber to the others.

Get healthy seed

A. Sorting at harvest time

Sorting at harvest time is usually done in the storage area before seed tuber is stored. Seed tubers are taken from healthy plant chosen either by positive or negative selection. When storing chose seed tuber with smaller class tuber measurements (less than 60 g/tuber)

B. Sorting in storage

Sorting is done at least twice at one and two month after storage. Some farmers sort as many as three or four times. This depends on the condition of the seed tubers at sorting and the amount of time available. If you find high levels of pest and disease, then you must sort more frequently.

At one month sort by removing and destroying tuber infected with pests and disease. Pests appearing during sorting are usually potato tuber moths. At two month, sort by moving and

destroying infected by pests and disease, and observe sprouting Turnover and spread out heaped seed potatoes to stimulate more uniform sprouting.

C. Sorting before planting

Sorting before is planting done twice; once in the storage area and again in the field before the seed potatoes are planted. Sort in the storage area by removing those seed damaged by pest and disease. You should not plant seed potato damaged by pest and disease. On other important characteristics to pay attention to when sorting is the uniform length of the shoots. In the field, seed potato that has been damaged in transport should also be separated out.

2.5.3 Treatment of seed tubers

Before they are put in to storage, seed tubers should be cleaned of any soil sticking to the tuber, as the soil can contain disease. Clean tuber by washing them, or airing them, spreading them out in the storage area. Ant soil stuck to tuber will fall off by itself. Tuber should be turned over at least once a day to help them dry more quickly.

To prevent potato tuber moths prom infesting the tubers, many farmers apply chemical, insecticides to seed potato in storage. This practice is very hazardous to the farmers healthy, even more so when the seed potatoes are stored in their homes. Seed potatoes in storage can also be covered over using leaves / branches of eucalyptus tree which serves as are repellent to insect.

2.5.4Seed storage

2.5.4.1 Storage conditions

Storage conditions influence sprout quality of seed potatoes. Proper storage will provided high quality, green, robust and uniform-length sprouts. Storage techniques vary depending on where storage takes place. Sometimes seed potatoes are stored in sacks, in baskets or spread out on top of each other. Using sacks or baskets can save space, but can cause uneven sprouting as tubers on the top sprout more quickly than those underneath. Furthermore, storing sacks or baskets on top of each other can damage seed tuber making them more vulnerable to pests and disease

If spread out in storage, tubers will sprouts uniformly. This requires a large storage area, which always be kept dry as damp or wet floors allow diseases, particularly tuber rot, to affect seed potatoes.

There are three storage lighting categories:

Dark storage: when there is no light in a storage area.

Advantages: *reduce pest attack in storage and produces seeds and potatoes with more uniform sprout growth.*

Disadvantage: *sprouting takes long time- up to 3 or 4 months. Sprouts are white in color showing that sprouting is not so good.*

Light storage: *when there is full light in a space. This can be sun light or electric light*

Advantage: *sprouts are robust and bluish in color, which is a good sprouting. Storage time is shorter at about 2-3 months.*

Disadvantage: *lighting increases the temperature in the storage area and cause seed tuber to sprout prematurely. Uneven lighting causes sprouts to grow irregularly and abnormally, with small and elongated sprouts. Full electric lighting will increase storage costs. Furthermore, pests like potato tuber moths enjoy relatively bright place and more damage occurs in these condition.*

Dark-light combination storage: *is storage technique used to overcome the drawbacks of the two methods above. Seed tubers are stored in the dark for two months; and then exposed to full light for the following month.*

Advantages; uniform and robust sprout growth, sprouting time is quicker, and potato tuber moth damage is low.

Disadvantages; requires more than one storage place and is more labor intensive.

Good storage conditions imply that:

Seed potatoes are stored in a purpose-built stand-alone storage area with good air circulation such as diffused light stores.

Average temperature in the storage area is kept to 18 degree siliceous

Light conditions are altered using the dark- light method.

Racks for spreading out seed tubers are used. Allow enough distance between the racks so you can turn over the seed tubers.

Seed tubers are not piled up to a depth of more than 20 cm.

Seed tubers are observed, sorted and turned over once a month.

2.5.4.2 Pest and disease management during seed storage

Pests and disease that affect tuber in storage are potato tuber moths, bacterial rot and mould. These diseases are carried by the tubers themselves or caught from other affected tubers.

Take the following stapes to manage pest and diseases in storage:

Build a good storage are with good air circulation and adjustable lighting. The temperature inside should not be hot and the air should not be too humid.

Clear away potato remnants, sacks or any other waste, as these can be breeding grounds for potato tuber moths.

Make routine observations looking for pest and disease infected tubers.

Manually remove and destroy seed tubers affected by pest and disease.

If potato tuber moths are problem, sprinkle GV on to the affected potato tubers.

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2.6 Potato cultivation practices

2.6.1 Choice of location

What are the best conditions for potato to grow? Potatoes can grow well in area with:

An elevation of more than 1000meters above sea level. Under Ethiopian conditions, the best elevation is 1500metera above sea level.

Daily temperature ranging between 10-22degree silicious, with an average of 15 22degree celisious.

Around 12 hours of daily light a day.

Adequate water supply. This could be high rainfall around 1500-2000mm, with a balanced pattern of rainfall between the dry and rainy seasons. In areas with relatively low rainfall, irrigation management is a crucial factor. The best potato is grown in dry irrigated land.

Friable sandy soil that contains organic matter so it is highly fertile and drains well.

Soil free from bacteria wilt, nematodes and viruses, particularly when cultivating seed potatoes.

2.6.2 Potato varieties

In their place of origin (South America), there are many potato varieties, some of which are indigenous varieties and other of which are hybrids. Thousands of varieties with their manifold strengths and weakness are cultivated in South American countries.

Farmers in Ethiopia plant several varieties such as Jalene, Gudene, and newly released variety called Belete.

2.6.3 Field preparation

2.6.3.1Tilling the soil

Preparing field for potato requires heavy tillage turning the soil over. You can use hoes, tractor or ploughs in tilling to a depth of around 20-50cm. Hoes are usually used when tilling the soil to the depth of 50cm. this is done in two stages; the first is to a depth of 20cm, and then the second is digging and turning the lower layer of soil over for a further 30cm.

When tilling the field, remove unwanted weeds, especially grasses. Collect the weed and burn them after they are dry. Another method is to burn them more than 50cm down so they cannot grow again. Leave tilled soil for one week in order to neutralize soil temperature before planting any potatoes.

The benefits of tilling by the turning over soil are:

It allows other part of the soil to be planted thus maintaining soil fertility.

Improves the condition of the soil.

It controls weeds.

It exposes pests and diseases present in the soil to sunlight and cause them to die.

Nevertheless, tilling the soil can:

Change the composition and balance of living organisms in the soil and reduce soil fertility.

Increase erosion. Newly tilled soil is very crumbly and easily carried away by water.

Accelerate decomposition of organic matter.

To avoid this negative impact, you need to add organic fertilizer immediately after tillage and till lightly.

2.6.4 Planting

2.6.4.1 Planting time

A good time to plant potatoes is at the end of the day season or the end of the Rainey season. It is best to determine when to plant by considering the critical period for plants and how that will relate to environmental condition. The critical period for potato plants is during the vegetative growth stage. At this stage they should not get too much rain or wined, or be too dry. Soil should be sufficiently moist when planting, as moist soil can accelerate plant growth.

2.6.4.2 Planting method

When planting without mulch, place seeds are the planting point with their sprout facing up wards. Apply chemical fertilizer to their left and right. Potato farmers generally apply chemical fertilizer on top of the manure. This is not recommended as it is untimely, unless the fertilizer contains phosphorous. Cover the seeds and manure with soil to a thickness of 10-15cm.

The recommended spacing for planting potato is 75 by 30 cm. A crop planted for the main purpose of producing seed size tuber may be planted as a higher density, such as 60 by 30 cm.

2.6.4.3 Intercropping

You can intercrop potatoes with other crops such as kidney beans or spring onions. These can be planted on the edges of the raising seedbeds.

How to plant

Plant two rows of kidney beans per seedbed between the rows of potatoes.

Plant spring onions alternately to the sides of the potato plants.

Advantages of intercropping are:

It provides another source of income for farmers.

The other crop can trap or deter insect pests and reduce spread of disease.

Intercropped plants can attract natural enemies. For instance, parasitoids prefer to attack leaf miner fly larvae on kidney beans planted among potato plants.

Intercropping with pulses can improve soil fertility. As pulses can harness nitrogen from the air.

Disadvantages are:

Intercropping can increase plant density making the environment damper and stimulating the development of diseases.

The main and secondary crops complete for space and nutrients.

The secondary plants can be a source of pests and diseases.

Hilling up and weeding

When you use mulch, hilling up is not necessary and weeding only involves pulling up those weeds present in planting holes or furrows between seed beds. When you do not use mulch, you should weed and hill up at the same time as applying fertilizer. Do this at least twice in a planting season; at 4 weeks after planting and at 6to 8 weeks after planting.

Weed by pulling up weeds directly or by scraping them out of the soil with a hoe, collecting them and burying or composting them. If there are not so many weeds are those percent are not graces, dig them out and pile them up around the plants.

Hilling up is done initially by loosening the soil around the potato plants, and piling it up around the plants. The height of the ridges after the first hilling up should be around 30 cm. For the seconded hilling up, remove soil from the furrows and pile it up around the plants. You should do this more carefully to avoid damaging the plant roots. The height of the ridges after the second hilling up should be about 60 cm.

***Advantages of weeding and hilling up**:*

Covers fertilizer and prevents fertilizer loss resulting from evaporation or washing off.

Gets rid of weeds thus preventing competition between potato plants and weeds.

Loosens the soil helping potato plants to better develop roots.

Makes water flow more easily down the furrows and prevent flooding in the rainy season.

Improves environmental conditions of the plants and the soil.

Covers potato tubers forming close to the surface of the soil, hence reducing the risk of damage from potato tuber moths.

Disadvantages of weeding and hilling up:

Can damage potato plant root system.

Can cause lesions on the roots and tubers, thus increasing the risk of disease.

Water management

2.6.6.1 Irrigation systems

Irrigation systems are systems that allow water to enter and leave the field. They should be planned and constructed before planting begins.

Good irrigation systems:

Prevent the field from flooding.

Prevent the entry and spread of water-borne diseases.

Make it easy for water to enter the field when plants need it, especially in the dry season.

Potato fields should have a minimum of three lengthwise and three transverse water channels. For each direction this implies two channels at the edges and at least one in the middle. These channels should be deeper than the furrows between the raised seedbeds.

2.6.6.2 Watering

Watering potato plants is very important in dray season. Sloping fields in potato planting regions make water management a crucial factor in the success of potato crops. You can irrigate potato in two ways; by using water channels or by watering using hoses, buckets, etc.

Table 2.4 Advantages and disadvantages of the two irrigation methods.

	Using irrigation channels	***Using hoes, buckets, etc***
Advantages	*Makes the fields wetter* *More even distribution of water across the field* *Less expensive*	*Can be done even when the water source is far from the field* *Prevents water-borne disease being carried in to the field* *Does not require a complicated system of irrigation channels*
Disadvantages	*Difficult to do if the water source is far away/or lower than the field* *Water flowing in or between fields can spread wetter-borne diseases* *Requires a complicated system of irrigation channels*	*Watered areas not very wet and watering is un even across the field* *Require more expensive equipments* *Is labor intensive*

2.6.6.3 Water management and water-borne diseases

Water can lead to an increase in diseases in the following ways:

Increased in moisture levels around plants, caused by flooding for example, can lead to arise in leaf blight, stem-end rot and bacteria wilt.

Water can carry disease from one plant to another. Water-borne disease includes bacteria wilt and tuber dry rot.

Proper water management in potato fields in essential in preventing the above from occurring. Key points:

Water should be able to exit the field easily when it rains.

If bacterial wilt is discovered, it is best to water using hoses or buckets to prevent it from spreading in water flowing on the surface of the soil.

Crop rotation

Reasons for rotating crops are:

Avoiding increased levels of pests and disease damage. *Potatoes cannot be planted two to three times in a row. Increased populations of pests and diseases from one generation to the next make it difficult to achieve satisfactory harvests with the next crop. This is particularly a concern for golden cyst Nematode. Bacterial wilt will increase in prevalence in the second and third consiquative crops. Leading to a substantial reduction in yield. Even through bacteria wilt survives for about two year in the soil, rotation with other plants, particularly corn. Cabbage and sweet potato, can reduce level of infection in the next potato crop.*

Exploiting the most appropriate time for planting potatoes. *The successes of a potato crop are influenced by the weather .High rain fall and drought can both cause potato crop frailer. During certain months of the year, farmers should substitute their potato crops with other safer plants.*

Maintaining and improving soil fertility. *Continual planting of potatoes can reduce quantities of nutrients in the soil. Potato plants need large quantities of nutrients, so rotation with crops such as pulses and sweet potato can help maintain and increase soil fertility.*

2.7 Potato Diseases ecology and management (Rich,A.E. 2001)

2.7.1 Plant disease and their causes

Disease is a process in which certain parts of plant are infected by a microorganism and cannot function properly. Common cause of disease and fungi, bacteria and viruses, which are incredibly small organisms mostly in visible to the naked eye.

The various disease causal agents are characterised as follows:

Fungi*- these are important agents of diseases because there are so many kinds. Fungi have many cells that are formed like threads, and can reduce from cut threads or spores. These disease agents can enter plants activity through lesions, natural hoes and plants, be carried by insects, or enter directly through the surface of a plant. Fungal disease can spread through water, oil, wind and seed and on farming tools. One example of a fungal disease on potato is late blight.*

Bacteria- *Bacteria, smaller in size than fungi, are single-celled organisms capable of reproducing by spores and splitting themselves. They develop incredibly rapidly in supportive environmental conditions. Bacteria enter plants passively through lesions and natural cavities or are carried by insects.*

Diseases caused by bacteria are bacterial wilt and tuber rot.

Viruses- *viruses are even smaller than fungi and bacteria. They cannot live independently and have to be supported by living in the cell of other organisms. Viruses require plant cells to split and reproduce. Viruses spread from one plant to another through plant matter (seeds), or carried by insects such as thrips and white flies.*

Disease are more difficult to detect than insect pests, because their cause are extremely small and invisible to eye. The presence of a disease is only apparent when symptoms being to appear.

2.7.2Major potato disease

2.7.2.1 Bacterial disease

A Bacterial wilt

Bacterial wilt is a disease caused by the bacterium Ralstonia solanasarum. It does not only infect potatoes, but cannot damage plants such as chilli, tomato, tobacco and eggplant, as well as several species of weeds. This disease is extremely dangerous, especially in regions where potato are cultivated insensibly such as shashemenie. In some areas, it is the biggest cause of reduced production. Fungicides are sometimes used by farmers to control this disease but these are ineffective, because the casual agent is not a fungus.

Symptoms

The symptoms of bacteria wilt infection can be seen on all parts of infected plants. They begin to wilt, starting for the tips of the leaves or where the stems branch out, and then spreading to all parts of the plant. Leaves become yellow at their bases, then the whole plant wilts and die. When stems are cut a brown cooled ring will be visible.

Mildly infected tubers will not show any outward singles of disease as symptoms will be hidden from view. When a tuber is cut in half, black or brown rings will,

however, be visible. If left for a while or squeezed, these rings will exude a thick white fluid coming out of tuber eyes. This can be signified by soil sticking to tuber eyes when crops are harvested. Serious infection causes tubers to rot.

Source and spread

On potato crops, Bacterial wilt originated from:

Soil-bacterial wilt can survive in soil without a host for several seasons.

- *Water.*
- *Seed tuber.*
- *Rogue potato plants or other crop or weed plants that can host bacterial wilt.*
- *Potato plant remnants.*

The diseases can spread from field to field or from plant to plant in one field via:

- *Infected seed.*
- *Water.*
- *Soil.*
- *Farming tools.*
- *Livestock and people.*

You must not store tubers infected with bacterial wilt or use them for seed. The diseases will spread rapidly in the warmer temperatures in storage areas, and will cause tubers to rot. Infected seed can also be a source of the disease in the field.

Management

Bacterial wilt cannot be controlled with fungicides, and bactericides are seldom available to farmers and generally very expensive. Management principles for bacterial wilt as follows:

Remove sources of disease from the field by:

- *Planting potatoes in soils free from bacterial wilt.*
- *Using healthy seed not infected with bacterial wilt.*

- *Rotating potato crops with other non- solanaceous crops such as cereals. Good practices are to rotate potatoes with corn or sweet potato. In fields with serious infections, it is best to plant non-host plants for more than ten years, as agents of bacterial wilt can survive in the ground without host for that amount of time.*

- *Removing infected plant debris before planting and clearing weeds away before planting, while plants are growing and at harvesting time.*

- *Using composted organic fertilizer not infected with bacterial wilt.*

Inhibit the development and spread of bacterial wilt in the field by:

Putting dolomitic lime on the soil around infected plants as this increases soil PH, creating a less favorable environment for the pathogen.

Carefully managing irrigation in the field by digging channels that allow water to flow free from the field. Bacterial wilt will spread rapidly in flooded fields. Also when watering the field, try to make sure water does not flow over the surface of the field.

Using water not contaminated with bacterial wilt to irrigate the crop.

Cleaning the field by destroying (burning or burying) plants and tubers infected with bacterial wilt through the whole season.

Cleaning farming tools after use.

Observation methodology

You can begin making field observation for bacterial wilts at 35 DAP by looking at symptoms on affected plants. Identifying un infection as bacterial wilt can be done by using the following methods:

Testing plants with vascular flow test *– This will determine whether plants with symptoms of wilting are infected by bacterial (and non fungal) wilt.*

Cut 2-3 cm lengths off stems at the base of plants showing singe of infection. Suspend these pieces vertically in water and leave for a while. If the plant is infected with bacterial wilt, milky thread of bacterial ooze will flow from the stem pieces in to the water.

Testing tubers *– cut a sample tuber near bits base. Leaves it for a few minutes, or squeeze it. If it is infected with bacterial wilt, it will exude a thick white fluid.*

Testing soil with bioassay test *– Three-week old tomato seedlings grown on BW-free substrate and several soil samples suspected of infection are used for testing. Put the soil samples in post and water them with clean water. Plant five tomato seedlings in each pot, and grow them for one or two months. Make observations by looking at symptoms that appear on each of the plants in the pots. When wilting appears, test the plants with vascular flow tests. Wilting plants that exude a milky flow in the vascular flow test are proof that their pots contain infected soil. You can also do this test to determine if manure contains bacterial wilt.*

2.7.2.2 Fungal diseases (mold)

A Late blight

This is the most important disease caused by the fungus phytophthera infestans, affecting potato crops in the tropical highlands. It regularly causes crop failure, infecting plants from the tuber initiation stage up until harvest. Several infections occur at times of high rain fall, high humidity and low temperatures.

Symptoms

This disease damages leaves, stems and tubers. Affected leaves appear blistered as if scalded by hot water and eventually rot and dry out. When drying out, leaves turn brown or black in color. When infections are still active, spots appear on the undersides of leaves blanketed in what looks like flour. Affected stems begin to blacken from their tips, and eventually dry out. Severe infections cause all foliage to rot, dry out and fall to the ground, stems to dry out and plants to die. Affected tubers display dry brown- colored spots on their skins and flesh. This disease acts very quickly. If it is not controlled, infected plants will die within two or three days.

Sources and spread

Sources of late blight are the air, soil, seed and remnants of infected plants. It spread very rapidly via air, soil, water and seed. The white powder on the surface of affected leaves can be carried by the wind and spread the disease to other plants.

Management

This discussion is for farmers who can identify the symptoms of late blight. Late blight management practices must be based on the relationship between the disease and factors that influence its development. These factors are as follows:

- *The amount of initial inoculums to start the disease off with.*
- *The rate at which the disease progresses.*
- *The time since the initiation of the disease.*

Key practices in late blight management are (1) the use of resistant varieties (if available), (2) routine observations, and (3) developing management techniques based on these observations. Varieties with good resistance to this disease are not yet commonly available to Ethiopian farmers; however gudene and especially the new variety belete have a good degree of tolerance against late blight.

The key points to reduce late blight infestation are:

- *Limiting initial inoculums of the disease in the early plant growth stage.*
- *Reducing the spread of the disease.*
- *Reduce the duration of the disease.*
- *Avoiding the serious contamination of the environment.*
- *Reducing potato production costs.*

B Early blight

Early blight caused by the fungus Alternaria solani is found in all potato producing regions. It is not as important as late blight, because it rarely cause severe damage or crop failure.

Symptoms

Early blight affects old leaves; its symptoms are dry brown spots, usually bound by the leaves ribs. This disease first become apparent during the tuber bulking stage and develops leading up to harvest.

Source and spread

Source of infection are contaminated seed plant remnants. The disease is spread via wind, water, soil and seeds.

Management

Management should be carried out when this disease is discovered in the vegetative growth or tuber initiation stages.

Infection in the tuber bulking stage does not affect harvest quality or yield; therefore, it is not economical to manage the disease during this stage.

Management techniques for this disease include:

Removing sources of infection, using healthy seed, destroying contaminated plants and crop rotation.

Using good irrigation system to prevent the disease spreading through water.

Balanced use of fertilizer to produce health plants more resistance to infection this disease.

Cutting back steam at 80-90 DAP, to prevent the disease spreading to tubers.

viral diseases

A common problem when cultivating potatoes is reduced yield from one generation to the next. Farmers often consider the cause to be old and degenerated seed potatoes.

Infarct, this yield reduction is caused by viral infections residing in the seed tubers. These diseases are very varied and display a multitude of symptoms. It is difficult to gain an understanding of viral disease because:

Their causal agents are tiny and invisible to eye.

Viral infection rarely causes plant to become damaged or die. The symptoms visible, if any at all, are changes in the shape of plants. Consequently, most farmers consider viral diseases harmless.

It is difficult to differentiate between symptoms of one viruses and another, as they are all similar. Thorough testing call for equipments and expense well beyond farmers reach.

Viral disease has well developed from one generation to the next primarily due to farmer's habit of basing their seed potato selection on the size of the potatoes alone. Generally viral diseases lead to smaller potato tuber being produced. Consequently, when tubers are sorted and selected for seed, the majority of seed potatoes chosen already infected with viral diseases.

A key factor when obtaining seed from your own field is selecting healthy plants for parent stock.

Despite variations, management principles are nearly the same for all viral diseases.

Viruses can be controlled by:

Using virus free seed:

It is very risky to select seed potatoes based on size alone, as plants infected with viral disease generally produce smaller tubers. Strict sorting and selection is highly recommended when a part of the harvest will be used for seed.

Destroying plants infected with viral diseases:

Plants displaying symptoms of viral diseases must be pulled up, collected and destroyed. Viruses can spread from one plant to another through vectors, so removing infected plants will also remove the source of diseases for other plats.

Controlling insects that can spread viral diseases:

Generally, sucking insects such as aphids, thrips, mites and whiteflies can spread viruses. Therefore, management of these insects can reduce the spread of viral diseases.

Leaferoll virus

Potato leafroll virus (PLRV) is an important disease in a potato plants, and can cause reduced yields for up to 90 %.

Symptoms

Leaves curl upward and turn pale yellow. If you press them they feel brittle and fragile. In advanced infections, plant grouse become stunted, leaf stem stand upright, leaves curl, tighten and turn pale green. Severe infections cause potato plant to produce tiny tubers, or prevent them from producing any tubers at all.

Source and vector

PLRV can be introduced in to a potato field by infected seed tubers or by aphids who act as vector spreading the diseases from one field to another.

Observation methodology:

Symptoms appear during the early stage of potato growth, so observation should begin at that time. Make observations by walking along the raised seedbeds and looking for plants showing symptoms of the disease.

Potato Y virus

Potato Y virus (PVY) is the second most important virus. It can be passed on through infected tubers or by insects and can reduce yield by up to 80%.

Symptoms

Leave surface become uneven brittle, leaves shrink and their ribs turn yellow. In mild infections, plants often show no signs of disease at all.

Source and vector

Although the virus can spread with infected seeds tubers and mechanical transmission through tools and plant/tuber handling, PVY is mostly transmitted by aphids who act as vector spreading the disease from one field to another. Aphids can acquire the virus within seconds after starting to feed on infected leaves, can transmit the virus immediately, in a non-persistent manner and usually retain the virus for only several hours without continued feeding on infected leave material.

Observation methodology

These are the same as for leafroll virus.

2.7.3.3 Mosaic virus

Symptoms

Yellow-green stripes appear on leaves infected by the potato mosaic virus (PVM). Yield can diminish by up to 40%. In mild infections, affected plants display no symptoms.

Source and vector Like other viruses, PVM is caused by using contaminated seed, can be mechanically transmitted through tools and plant/tuber handling or is from other plants by aphids.

Observation methodology

These are same as for leaf roll virus.

2.8 Potato weed management (Potato Farmer Field school Handout 2011 CIP)

2.8.1 Weeds: damaging or beneficial?

Weeds are all the unwanted plants growing on farming land. They compete with the main crop and considered to produce nothing of any benefit.

Weed are damaging when:

They compete with potato plants for nutrients, sunlight, water and living space.

They require expenditure in their control.

They become a food source for pests enabling them to thrive, even when there are no potato plants in the field.

They host diseases that affect potato plants. Crop rotation will not work if diseases and pest supporting weeds are still present in the field.

Weeds can be beneficial when:

They serve as green manure providing traces elements and improving soil structure. Weeds form a fundamental ingredient in making organic fertilizer.

They form a covering layer protecting soil from sunlight or erosion damage.

They become a food source for natural enemies. Weeds produce flowers and nectar that can be an alternative food source for parasitoids.

They become a food source for livestock.

Whether a weed is damaging or beneficial depending on its species, its density and its uses. For example, a weed will be extremely useful if it can be sued for animal feed.

2.9 Harvest and Post Harvest Management

2.9.1 Pruning plants before harvesting

It is recommended to cut the foliage of potato crop before harvesting when some of the produce will be used for seed. Under tropical highland conditions, this can be done at 80 DAP (depending on the variety), by cutting them at the bases of their stems. The foliage can be collected and composted.

Benefits of pruning are:

- *To produce more seed size tubers.*
- *To make tubers harden more quickly so they can be harvested sooner. Normally, you can harvest plants two week after pruning.*
- *To prevent diseases spreading from plant stem to tubers. Viral diseases in particular will spread to tubers if stems being to wilt and dry out. The*

same occurs to other disease such as late blight, stem rot and bacterial wilt.

2.9.2 Harvest time

Each variety has a different preferred harvest age it is best to harvest in clear, sunny weather, because sun shine will help tubers to harden and dry more quickly, making it easier to remove

Harvest time is influenced by potato price and weather. When price and weather are favourable, you can harvest a bit earlier and spread the produce out for a few days to allow tuber skin to harden.

However, when price and weather are not favourable, you can delay harvesting. Harvesting in rain must cause tuber to rot. You should not delay the harvest for more than 10 days, as delay of any longer will cause more tuber to become damaged by pests such as mole crickets, or bacterial disease and scab. Damaged tubers will fetch a lower selling price.

2.9.3 Harvesting methods and estimating yield

Harvesting methods affect tuber quality. Potatoes can be harvested in two ways, directly by hand or by using a hoe. Harvesting by hand take longer and is more labour intensive, but will produce good quality, undamaged tubers. Using a hoe is less time-consuming and labour- intensive, but some tubers will be damaged in the process.

On loose soil with no grasses growth, you can harvest by dismantling potato beds by hand. Harvested tubers should be put to the side of the dismantled seedbeds so they are easier to collect. When soil is too hard and is covered with grass, you should dig up potato beds using a hoe. This can happen when you harvest too late at more than 120 DAP. Dig from the edge of the seed beds to loosen the soil, and then continue dismantling them by hand. Be careful when loosing the soil so as not to damage potato tuber.

If the whole produce is going to be sold, then you can harvest all the potato in one go. However, if some of the tubers are for seed, you should harvest them at a different time from the ware potatoes. You can harvest seed tuber either before of after harvesting tuber for consumption by using either positive or negative selection.

After harvesting, you should sanitize the field, by gathering and destroying harvest remnants such as plant parts, rotten tubers etc. Post-harvest sanitation is

an important part of controlling various pests and diseases, by removing source of contamination for the next crop from the field.

You can estimate potato harvest yield by:

Weighing several sample tubers taken from randomly selected plants.

Calculating the average weight of tubers per plant.

Multiplying that figure by the total number of seed tuber used (or plants grown) on the whole field.

For example

The tuber weights of five sample plants are 0.9, 0.8, 1.2, 1.0 and 0.5 kg. The average weight of tuber per plant is:

$$\frac{0.9 + 0.8 + 1.2 + 1.0 + 0.5}{5} = 0.88\text{kg/plant}$$

The average tuber weight per plant is multiplied by the number of plants in the whole field to assess the total harvest. For instance, a 1,000m2 field contains 2,000 plants. The estimated harvest from the example above is then:

$$2{,}000 \times 0.88 = 1{,}760\text{kg (or 17.6 tons/ha}$$

If the number of plant is not known, it can be accessed from the seed rate. For instance, a farmer planted 100kg of seed tuber with an average weight of 50g per tuber. Number of plants is then.

$$\frac{100}{0.05} = 2{,}000 \text{ plants}$$

The estimated total harvest is $= 2{,}000 \times 0.88 = 1{,}760\text{kg}$

2.9.4 Treatment of produce

Harvested tubers are treated as follows:

Spreading out and draying tuber – spread out harvested tubers in the field or the storage area to dry. Harvesting in dry season enable you to leave the produce in the field for a long time. In the rainy season, it is best to spread out the produce in the storage area under lights.

Sorting – do this by separating damaged and undamaged tubers and classifying them according to weight. Gather and destroy any rotten tubers. Tubers damaged by pests can be sold. Tuber classification varies greatly between countries and regions. An example of tuber weight classification is as follows:

> 80gm/tuber

60 – 80 gm/tuber

30-60gm/tuber

< 30gm

Tubers weighing 60 gm and over are sold, whereas those of 30 to 60 gm are normally used for seed.

Packing – you can do this by using sacks or baskets. Packing must be done carefully to avoid bruising tubers.

Transportation to the storage area – produce can be sold while it is still in the field, particularly when price are high and not too many potatoes are available.

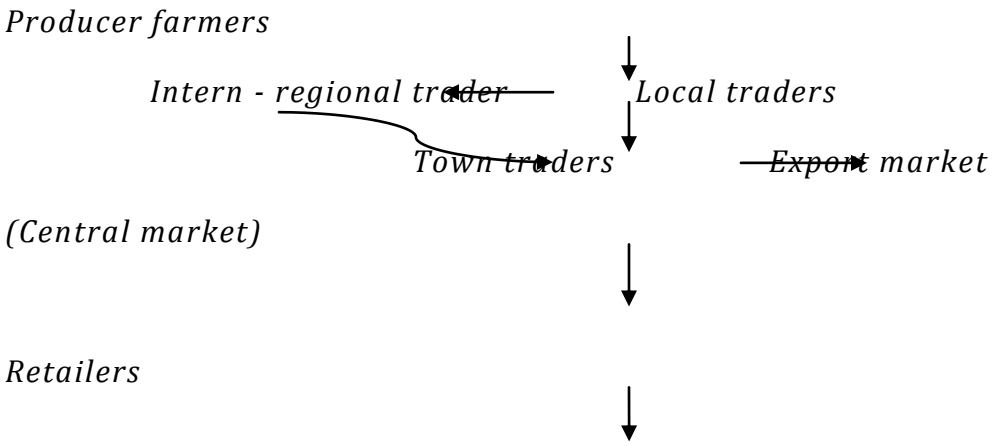
When the main harvest takes place, farmers must store harvested tubers in a storage area until prices improve. Be careful to avoid any damage when transporting produce from the field to the storage area.

Storage – tuber for consumption are only stored for a few days. If you are store them for more than two days, it is best to spread them out of the dry floor of the storage area to prevent them from rotting.

Tuber selection for seed – selection is done for tubers affected by pests and disease, and tuber size. It is advisable to separate tuber from different weight classes to make it easier to estimate seed requirements. A one-hectare field generally requires 1.5 tons of seed tubers weighing 30-60gm/tuber, but only about 1 ton of tubers lighter than 30gm/tuber.

2.9.5 Marketing and price

In some areas farmers generally sell potatoes in their own village, while in other areas traders will come right to village's homes or field where potatoes have recently been harvested. An example of potato marketing channel is depicted Figure 4. Price are usually are not too different from one farmer to the next at the same moment in time, and are mainly influenced by tuber size, quality, smooth skin, colour and whether or not they are damaged. Potato price can fluctuate greatly from season to season, though. Farmers should quickly speculate information on potato price among themselves to avoid cases of trades taking advantage of them.



Potato marketing channel

2.9.6 Potato processing

Potatoes can also be processed in to various food industry products. The food processing industry requires increasing numbers of potatoes every year. The currently used varieties are not particularly well suit for processing; however, new varieties with good processing qualities will be released in the near future.

2.9.7 Analyses of the potato enterprise

An economic analysis provides information on the status of farmers' businesses and whether they are making a loss or a profit. This information can provide the basis in developing cultivation patterns for the following seasons' harvest. Net income or profit from farming is the amount remaining when you subtract

expenditure from gross income. Both income and expenditure vary from one farmer to the next.

Income from potato farming:

Selling potatoes for consumption.

Selling seed.

Selling the produce prom intercropping.

Type of expenditure vary greatly from farmers to the next, but generally consists of the following cost items:

Purchasing seed.

Purchasing organic and inorganic fertilizer.

Purchasing sacks to packing harvest produce.

Purchasing fungicides, insecticides, adhesives etc.

Labor costs, from tilling to harvesting.

Transportation costs, when buying inputs.

Spraying equipment rental costs or depreciation value.

Other potato enterprise related cost.

Important factors in determining gross income are the amount of tubers that can be sold for consumption and for seeds, and the price of those consumption and seed potatoes. Important factors in calculating expenditure are the number of goods and services used as wall as the size of other expense. Usually, farmers only count income and expenditure in cash form. This means 'wages' for farming family members and the value of goods belonging to farmers are not counted. For example, farmers need not include spraying equipment hire when they already have their own, but the depreciation value of the sprayer for that particular season should be included as an expense.

Potato farmers should always record their income and expenditure every planning season. In the FFS process, farmers may went to calculate their businesses based on the notes they take. It is recommended to note down the following things as each meeting:

***Activities** – what work they have done in the study plot.*

Labor *– wages paid for workers and estimated pay for work done by the farming family.*

Purchase of inputs needed for cultivation - what inputs have been bought, and how much they cost.

At the end of season, the two columns containing amounts of many (labour and production costs) are added up and recorded on analyses sheet of the form. When the produce has been harvested and sold, the gross income is also noted down and calculated in the analysis sheet, and the farm economic analysis can be done by calculating the profit.

Gross income *- total harvests (kg) multiplied by product press (money value per kg).*

Total expenditure *– by adding together the costs and production costs.*

Profit *– total expenditure subtracted from total gross income.*

2.10 POTATO SEED SUPPLY SYSTEM IN ETHIOPIA

There are two seed supply systems in Ethiopia

The local/informal/farmers' seed supply system and the formal

Some 85% of the Ethiopian farmers are believed to depend on the formal

- *Owes its origin to the establishment of the Alemaya*

sCollege of Agriculture in mid-fifties and the Institute of

Agricultural Research in mid-sixties

- *The institutions engaged in developing improved varieties*
- *Seeds developed by these institutions were initially*

Introduced to farmers in 1967.

- *Production of improved commercial seed for cereal, pulse*

And oilseed crops was institutionalized in 1978 through

The establishment of the Ethiopian Seed Enterprise (ESE)

• *In order to overcome the serious food security concerns of the Country in general,*

And to streamline the supply of improved Seed, in particular, a mix of formal and informal seed sector Development strategies have been adopted since 1991.

- *Formal seed supply system*

– Ethiopian seed enterprise (ESE) is the major is the major seed Producer in the country

– It mainly produces and supplies seeds of cereals, pulses and oil

– The seed production and distribution by ESE for horticultural crops In general and potato in particular is almost non-existent

– There two seed potato producers' cooperatives; one in Jeldu district

And the other in Wolmera district

– Besides two other cooperatives are in the process of recognition

– Very low capacity of the ESE and unavailability of other institutions

- *Informal seed system*

– is the main source of seed potato

– Seed sources are local markets and previous harvest

– The seed are low in quality

– They are usually inferior tubers that could not normally be Sold for consumption

– in some parts of Ethiopia farmer based seed production

(FBSP) has been practiced for seed potato

– In FBSP approach,

- *farmers are provided with relatively clean starter planting*

Material of a variety they want and basic skill training on potato

Seed production

– Farmers organized in FBSP serve as sources of potato for

Most of potato growing areas in the country

2.11 Sustainable Seed Potato Production in Ethiopia: from Farm-Saved to Quality Declared Seed

In potato production, seed quality is an important determinant for the quantity and quality of the tuber yield (Struik and Wiersema, 1999). Current yields in Ethiopia are low (8 t ha^{-1}) but could easily be doubled or tripled. Perhaps the most significant constraint to increasing productivity and overall production is the chronic shortage of good quality seed tubers. Seed systems can be defined in the way farmers produce, select, save and acquire seeds (Sthapit et al. , 2008). In the absence of a commonly agreed definition for different seed systems, this paper will differentiate between three different types of seed production systems, i.e. formal, alternative and informal seed production systems. The formal system involves seed certification by Ministry of Agriculture according the Ethiopian Standard for Seed Potato (ES 494:2005). The legal framework for a formal root and tuber seed certification scheme is in place but not implemented. Given the Ethiopia's large area size, the still limited road infrastructure and the fact that seed potatoes are being produced by hundred thousands

of small-scale farmers (instead to few large-scale commercial producers), the costs for implementing a formal seed certification scheme would be prohibitively high; so the logistic requirement is extremely challenging. It is therefore unrealistic to assume that such a system could be under operation at a national level in medium term. However, it might be feasible to certify seed produced by

these few large-scale producers; particularly for those aiming at exporting potato seed to neighboring countries. In the alternative system, farmer cooperatives and farmer groups (farmer cooperatives in the following) with technical support and Supervision from the national research and extension system produce seed of relatively high quality, in the same way by special projects and universities. In contrast, the informal system is characterized by the absence of quality control mechanisms. Relatively poor quality seed, derived from farmers'own fields (farm-saved), and local markets or neighbors is planted for an unspecified number of generations. According to (Gildemacher et al. , 2009), the informal system is the predominant seed production system accounting for 98.7% of the total potato seed produced in the country while the alternative system meets 1.3% of the national seed requirements and no certified seed is being produced at present. To put these percentages into perspective, the quantities of seed involved should be considered. The total area cropped to potato in Ethiopia is around 160,000 ha (Gebremedhin et al., 2006). The annual seed requirement is therefore around 320,000 tons; out of which 315,840 tons (98.7%) are supplied by the informal seed system and the remaining 4,160 tons by the alternative system.

The informal and alternative seed systems will therefore remain to be the dominant seed production and dissemination mechanism in the country for the time being. Interventions designed to improve farmers'access to quality seed at affordable prices should therefore aim building upon the existing two systems, trying to improve seed quality and overall system efficiency. It is the purpose of this paper to provide an outline on how the alternative seed system could be strengthened by building upon the informal system and by introducing the concept of quality declared planting material (QDPM).

Improving farmer access to affordable quality seed

Seed quality is an important determinant for tuber yield and quality. The national research system and Solagrow PLC, a private company, are now producing potato mini tubers (Generation 1 – G1 seed). While in 2011 less than 60,000 mini tubers were produced, and it is likely that the total production in 2012 may exceed

300,000. The question remains, though, how could more than 2 million potato growing households benefit from this high quality seed, the mini tubers. A centralized approach whereby G2 (generation 2) and G3 (generation 3) seed is produced at only a few locations would involve huge logistic and cost to make this seed available to potato farmers in major rural seed production areas. This calls for a more decentralized seed production and multiplication system that is presented in the following. It links producers of pre-basic mini tubers with farmer-based seed multiplication and dissemination systems, thereby creating a new hybrid

System that incorporates components of the alternative as well as informal seed systems. Such a system would have the potential to give large numbers of potato farmers'access to quality seed. The initial source materials are disease-free in-vitro plantlets produced by the national research system and private tissue culture laboratories. These plantlets are grown in screen house or the newly built aeroponics units to produce pre-basic mini tubers (G1). Given the small size of the pre-basic mini tubers, experienced seed potato producers with under semi-controlled condition to give G2 seed should then multiply these; access to irrigation is an important requirement at this stage. These experienced multipliers include research centers, private enterprises, and leader farmers, ideally located at head points of traditional seed systems. These G2 seed is then sold to seed producer cooperative/ private sector multipliers who in turn may sell the subsequent generation to surrounding farmers: seed produced groups and private sector multipliers through farmer-to-farmer exchange. It is assumed that for the first two generations the entire produce would be kept as seed, however, as of generation three it is likely that an increasing proportion of the produce will be sold or consumed as ware immediately after harvest to satisfy farmers need for cash and food. It is difficult to assess for how many generations the seed will be recycled before used as seed for ware thereby reaching the consumer as ware potatoes. However, given experiences from other high-altitude areas, it is assumed that the seed could be multiplied for five to eight generations, especially if positive/negative selection techniques would be employed. Farmer Cooperative and Model Farmers located in these seed producing areas play a key role in producing quality seed, catering for their own seed needs and providing seed to other growers operating in that area. Such a system requires more input/ resources initially, however, once established, it may drastically reduce transaction costs and dependence on outside intervention and functions in a sustainable manner. The small volume pre-basic minitubers (5 to 20 g) ideally complement such a system, since they can easily be transported to remote multiplication sites located at head points of these seed flows. This again greatly reduces potential transport bottlenecks of more centralized systems. For such a system to make best use of these expensive minitubers, it is important that the head points of these seed flows are located at high altitudes where disease pressure is greatly reduced. Subsequent seed generations should then gradually move to lower altitudes and ware crops can be grown in the lowlands. Minitubers are currently multiplied at research centers (Holetta, Adet, and Mekelle) to produce G2 seed tubers. However, initial tests to multiply minitubers by farmer cooperatives are encouraging; for example, during the Meher season of 2011 farmers in the Gurage zone managed to successfully multiply these minitubers. Out of 1000 G1 minitubers, they produced 10,650 G2 tubers. This is an excellent

multiplication ratio of above 10 - a multiplication ratio of 6 to 8 was considered standard. This result show that farmers cooperatives are capable of successfully multiplying minitubers and the production of G2 seed that could be further decentralized into major seed producing areas.

Seed potato value chain

Seed and ware potatoes are distinct commodities that need to be treated differently from planting to harvesting and then storage. However, in Ethiopia value chains for these two commodities are largely identical. In the absence of a labeling system, it is difficult to distinguish seed tubers from ware potatoes in the market. A value chain analysis found that most seed potatoes sold in markets are simply graded and re-classified as ware potatoes. —Clever‖ traders, therefore, buy ware potatoes, declare them as planting material, and eventually sell them to farmers and other buyers / NGOs. Given this uncertainty, buyers of seed potatoes are reluctant to pay premium prices needed to justify the extra costs associated with the production of quality materials. It will therefore only be possible to establish separate value chain for seed potato if the following two pre-conditions are fulfilled:

- *Seed potatoes are clearly recognizable as such in the market; and*
- *Buyers of seed potato are assured that they purchase unadulterated, high quality planting material.*

Labeling

The first pre-condition is relatively easy to implement by introducing a labeling scheme for seed potato. Such a scheme is currently being piloted by EIAR, TARI, SARI and the BoAs in SNNPR, Oromia and Tigray with support by the —Wealth Creation‖ project, funded by the Common Fund for Commodities and the —Better Potato for a Better Life‖ project with USAID funding. Quality seed potatoes are produced and stored by seed producer cooperatives under supervision of research and extension staff.

At the time of sell, paper labels are provided to the cooperatives and attached to the seed bags. The labels state the name and address (Including telephone number) of the cooperative, the variety, weight and date of harvesting. The initial experiences are encouraging as the scheme helps to link seed producers and buyers and contributes to the branding of the producers. Cooperatives consistently producing good quality seed will become known in their region and customers are more likely to return in future.

Seed Quality Assurance

In the absence of an operational seed certification scheme, seed tuber quality described as in the alternative system is maintained by staff of research organizations and seed potato projects whose jointly ensure the minimum quality standards. However, as the demand for quality seed is growing, this system is gradually reaching its production limits. Moreover, in case where it relies on projects' interventions it is not sustainable. Alternative mechanisms at regional and/or local level need to be developed, tested, and promoted to ensure that the producers of planting materials adhere to minimum quality standards

Quality declared planting material

Ensuring that farmers have timely access to seed and planting material of good quality is one of the most important elements of successful agricultural production and development. Despite this reality, seed and planting material available to small-scale farmers in many parts of the world is often of insufficient quality, negatively affecting yields and undermining crop performance. This bottleneck is particularly acute in countries where small-scale producers dominate the production system and where fully-fledged seed certification schemes are not a viable option because of their high costs and logistical requirements. To address this bottleneck, FAO, in consultation with partners, produced a technical guideline on Quality Declared Seed (QDS) in 2006 for crop species propagated by true botanical seed. These guidelines are now used and consulted worldwide (FAO, 2010). However, vegetative propagated crop species have not been included in the QDS guidelines, despite their importance for agricultural production and food security. Therefore, FAO, in consultation with CIP and international experts, has developed protocols and standards for the production of Quality Declared Planting Material (QDPM) of the most important vegetative propagated crops such as potato, sweet potato, cassava and yam more recently (FAO, 2010).

It is the aim of the QDPM guidelines to raise the physiological and phytosanitary quality, and hence, yield potential of planting material available to small-scale farmers, thereby increasing agricultural productivity. The QDPM protocols allow for easy and low cost inspection of planting material and facilitate the production of planting material that fulfills agreed on quality standards. The assessments are based on visual observations made by trained farmers, research, or extension personnel. The QDPM guidelines need to be adapted to the prevailing conditions and available resources. The underlying principle is shown in Figure 3

as a function of]—inspection costs‖ and —seed quality‖, assuming a decreasing marginal benefit with increasing intensity of seed inspections. The best quality seed will be attained with a formal seed certification scheme, however, as discussed earlier, such a system is currently not a viable option for potato seed production in Ethiopia due to its costs and logistical requirements. Therefore, an acceptable compromise between cost and seed quality needs to be found. —QDPM light‖ refers to a minimum inspection intensity already resulting in tangible seed quality improvements while —QDPM intense‖ refers to a more sophisticated but also more expensive inspection regime. The QDPM concept does not intend to replace seed certification schemes. Rather it should be considered as an intermediate step towards the establishment of a certification scheme. As soon as conditions and resources allow it, the inspection intensity should be increased to further improve seed quality. The Government of Ethiopia is very much cognizant of the need to improve the quality of seed and planting material for achieving the ambitious targets set for agricultural growth in the current five-year plan. Recognizing that formal seed certification schemes may currently not be attainable, the QDPM concept forms part of the policy recommendation produced by the Agricultural Transformation Agency and is included in the new national Seed Proclamation.

QDPM guidelines for potato: An example

Based on the FAO guidelines for QDPM, the following production guidelines for quality declared potato seed tubers are suggested

- *Isolation: the seed potato crop should at least be 50 m apart from the next ware potato crop; and*

- *Crop rotation: At least a 3-year crop rotation should be maintained ensuring that the previous 2 years no solanaceous crops were produced on the seed potato plot*

At least one field inspection should be carried. In fields of less than 2 ha, 10 counts of 100 plants each are taken. The plants should be assessed based on the tolerances listed in Table 1. Aphid counts should be taken on all assessed plants. In case of a slight infestation (1 to 2 aphids on few plants), no measures need to be taken. In case of moderate infestation (2 to 5 aphids on most plants), the crop should be treated with an insecticide. In case of a severe infestation (>than 5 aphids on most plants), the crop should be treated with an insecticide and early haulm destruction is recommended. In addition, a post-harvest inspection should be carried out to ensure that the stored seed is graded to agree on seed sizes (e.g.

35 to 70 mm), the seed is stored in diffused light stores, is reasonably free of soil and that different varieties are kept apart. These tolerances would still need to be reviewed and adapted to the conditions/ constraints on the ground. Important is, however, to ensure that the selected indicators can be accessed through visible observations by trained persons (farmers, research and extension staff) without the need for expensive laboratory testing. The threshold levels need to be realistic and attainable by reasonably trained and experienced seed producers. If the tolerances are too strict, farmers will be discouraged to continue with the system, falling back to the informal system without any quality control. These guidelines would need to be adapted to the envisaged seed quality requirements, the inspection intensity and resources available for the inspections.

Inspection mechanism

Depending on the inspection intensity and, of course, availability of resources, two separate inspection mechanisms could be envisaged, roughly corresponding to QDPM light and intensive, as shown in Figure 3. The QDPM light would correspond to a self-inspection scheme implemented by seed producer cooperative themselves without direct outside support and follow up. Examples of such self inspection teams already exist in the country. Seed producer cooperatives around Holetta who have been supported by EIAR for several years have established internal inspection committees consisting of 3 to 6 members of the cooperative (Gebremedhin, pers. comm.). They visit the seed plots of all members and decide based on visual observations whether a certain plot fulfills the cooperatives requirements/ tolerances for seed production. In some cases, the cooperative even compensates members if their seed plot is rejected to encourage the farmer to comply with their recommendation to sell the produce for consumption purposes. examples clearly show that cooperative-level inspection systems are a farmer-acceptable and a viable option for low-level, informal seed inspection schemes (QDPM light). Building on these existing experiences, the system could be strengthened by agreeing on and applying uniform tolerances for pest and diseases and by training the self-inspection teams. Subsequently the system could be promoted and applied in other seed producing areas of the country. The QDPM light system could be further strengthened and formalized by establishing a second inspection committee, operating at woreda level (QDPM intensive). This committee should involve staff of research and development institutions present in the woreda and 1 or 2 representatives of the seed producer cooperatives. It may not be possible for this committee to inspect all seed plots in the woreda. Instead a sample of all seed plots of a cooperative would be inspected. Depending on the available resources, the seed plots may be inspected once or twice during

the growing season, in addition, a post-harvest inspection should be Disease, pest or defect Tolerance

- *Wart disease (Synchytrium endobioticum) Nil*
- *Late blight (Phytophthora infestans) 5%*
- *Powdery scab (Spongospora subterranea) 8%*
- *Tuber necrosis caused by strains of PVY 0.5%*
- *Soil (by weight) 2%*
- *Off-type seed tubers 1%*

Carried out to ensure that the seed is graded, stored in adequate conditions (diffused light stores), and that different varieties are clearly separated. The woreda-level committee should then estimate the total quantity of seed the cooperative has produced for sale. Based on this estimate, the committee provides the corresponding number of seed labels to the cooperative for the seed produced during this particular season. In addition, the cooperative should be awarded the title of ―Recognized Seed Producer‖ for a given period and should be authorized to market its seed as QDPM seed.

Footing the bill: who is going to pay for the inspections?

Production costs of quality seed potatoes are substantially higher than ware potatoes. This is explained by the fact that yields of seed crops are generally Lower than ware crops and by extra costs associated with rouging, dehaulming, And grading. In addition, seed tubers lose between 3 to 4% of weight during storage in diffused light stores (Endale et al., 2008) and farmer runs the risk of not being able to find a buyer for his seed. The inspection itself (transport, per diems, and accommodation) and the labels for seed potato bags increase the costs of QDPM seed even further. These costs may initially be borne by special projects supporting seed potato value chain; however, ultimately they need to be incorporated into the seed price paid by the buyer. To convince seed buyers that quality seed justifies the extra cost, substantial efforts in advertising and awareness creation, ideally in combination with field demonstrations by showing that quality seed does translate into visibly better yields and hence justifies the initial investment should be major activities at present. In this context a word of caution: The formal Ethiopian seed potato market is

Unique in the sense that it is dominated by institutional buyers (NGOs, MoA, EIAR, FAO and aid agencies). Farmer to farmer seed exchanges (gifts, bartering) does take place, however, only limited quantities of seed are being sold directly between farmers and neighbors. In the absence of well-established value chain for seed tubers, it is very difficult to assess the actual demand for quality seed. Therefore, efforts to produce quality seed would need to be matched by efforts to link producers to either institutional or private buyers of quality seed.

Seed potato vision for 2020

The Ethiopian potato subsector is vibrant, the potential of this crop to contribute to improved food security and nutrition are increasingly being recognized and future prospects for the seed potato subsector are bright. This is exemplified by increasing donor interest in the crop (viz Irish Aid) and the fact that the Disaster Risk Management and Food Security Sector (DRMFSS) of the Ministry to Agriculture has just created a task force for root and tuber crops to exploit the potential in emergency situations. For the year 2020, the author's vision for the Ethiopian potato sub-sector would be that average potato yields have doubled and overall production has tripled. Self financed, sustainable seed inspection system applying QDPM standards function without outside support in all major seed producing areas. QDPM seed meets at least 50% of the national seed demand. In addition, a formal seed certification scheme is in place for large-scale Commercial seed producers. The involvement of NGO and government agencies Into purchasing and distribution of seed tubers is greatly reduced as seed is traded directly from farmer to farmer and seed exports into neighboring countries generate appreciable amounts or foreign currency. An internet or mobile phone based information exchange platform is established, effectively linking seed producers and buyers and providing up-to-date market price information.

2.12 Potato Research and Development in Ethiopia:

Achievements and Trends

In Ethiopia, potato production increased considerably through the twentieth century. However, potato cultivation declined in the early 1980s, due in part to widespread infestation by late blight (Tesafun et al., 1985).In 1975, the area of cultivation was estimated at 30,000 ha, with an average yield of approximately 5 tons/ha. By 2001, Ethiopia's potato area had grown to 160,000 ha, with average

yields of around 8 tons/ha (Gebremedhin et al. , 2001). Potato can still grow on 70% of the 10million ha of arable land in the country (FAOSTAT, 2008). In the last 10 years, potato productivity has progressed from 7 to 11 tons/ha. Nevertheless, the current area cropped with potato (about 0.16 million ha) is very small and the average yield is below 10 tons/ha—far below the country's potential. Diseases, the lack of improved varieties, poor crop management practices, use of inferior quality seed tubers of unknown origin, inappropriate storage structure, poor seed system, and poor research-extension linkage are among the key factors contributing to this low acreage and yield. The national potato research program has made great strides in overcoming these production constraints, and this paper aims to present major potato research achievements in the last three decades.

2.12.1 Major Achievements

A Potato varieties *The local varieties, introduced earlier, may be of tsameparentage(Haile Michael,1979),suggesting that the genetic base of local varieties in the country is most probably narrow. Improving the productivity of potato, which is a demanding process, has occurred by trying to widen thegenetic base of potato. A selection program was started in 1973 at the College of*

Agriculture in Alemaya in cooperation with the Institute of Agricultural Research (IAR) and the International Potato Center (CIP) with a large number of seedling populations. A more coordinated improvement effort was started later in 1975. Introduction and evaluation of commercial varieties, germplasm, generation of local populations, and, more recently, introduction of advance materials were some of the strategies that have been followed to develop varieties by the National Potato Research Project (formerly known as the National Potato Improvement Program). A number of variety trials were conducted in different areas of the country to address problems of different agro-ecologies. As of 2010, 29 improved potato varieties with high-yielding potential, wide adaptation, and resistance/ tolerance to diseases and pests have been released (Berga et al., 1994) and are under production

B Crop management

The suboptimal agronomic techniques practiced by potato growers in Ethiopia are undoubtedly one of the contributing factors to the existing low average yield. Agronomic studies have been undertaken by different research centers to develop

a package of optimum management practices, together with improved cultivars, which are briefly described in the following sections.

Time of planting

Planting time varies from place to place and from variety to variety. It influences tuber yield and LB incidence. For maximum yield, potato should be planted when favorable conditions prevail for better growth and development. Farmers in northwest Ethiopia plant potato earlier in the season to escape LB infection. However, this practice exposes the crop to moisture stress at early growth stage for which potato is very sensitive and subject to considerable loss. Tesfaye et al.

(2008) reported that regardless of type of varieties, yield declined as planting date was delayed. Therefore, May 1–June 1 were recommended planting dates around Adet for potato cultivars and similar agro-ecologies that are LB susceptible and moderately tolerant/resistant. Similarly, early June was recommended for Emdiber (Gurage zone), Holetta (central Shewa), and other similar agro-ecological areas (Berga et al., 1994). Abdulwahab and Semagn (2008) recommended the last week of May to mid-June as an appropriate planting time for potato in the highlands of Ankober (North Shewa) and other similar agro-ecologies.

Seed tuber size and plant population

Seed tuber size and plant population density are among the major factors affecting the production and productivity of potato. According to Berga et al. (1994), spacing should depend on the intended use of the crop such as for seed or ware. Closer intra-row spacing of 10 or 20cm in rows 75cm apart would be beneficial for seed; larger seed tubers (45–55 mm) do better than the smaller ones. Wider intra-row spacing (30 or 40cm) were better, again on rows 75cm apart, for ware potato. Considering the amount of seed tuber required and type of output and synergy with other cultural practices, seed tuber size of 35–45 mm diameter, 60-cm inter-row spacing, and ridging once at 3–4 weeks of crop emergence were recommended for seed potato production. However, 35–45-mm diameter seed tuber, 75-cm inter-row spacing, and ridging once at 3–4 weeks from crop emergence was found to be optimum and recommended practices for

ware potato production at Adet and its environs (Tesfaye et al.,2008).

Fertilizer rate

Potato is naturally a heavy feeder crop. Economically feasible fertilizer rate varies with soil type, fertility status, moisture amount, other climatic variables, variety, crop rotation, and crop management practices (Smith, 1977).Research results indicated that 108/69 and 81/69 kg/ha N/P2O5 were economically feasible and optimum rate for potato production in south Gondar and Gojam areas, respectively (Tesfaye et al., 2008). For optimum potato tuber yield in nitosols and light vertisols of the highland areas of north Shewa, 110 kg/ha nitrogen and 70.5kg/ha P2O5 kg/ha were recommended (Abdulwahab and Semagn, 2008). Berga et al. (1994) recommended 165/90 N/P2O5 as feasible rate for the central Shewa, and this recommendation is still in use as blanket recommendation throughout the country. In the same way, 146/138 N/P2O5 was recommended as economic and agronomic rate of fertilizer for the highlands of Hararghe (Teriessa, 1995). These recommendations may not work for the current market, soil fertility status, and other climatic variables. Therefore, detail soil test-based fertility studies should be carried out to provide appropriate local recommendations.

Intercropping

Intercropping of potato with maize is a common practice in northwest Amhara region. Consequently, an experiment was conducted at Adet for two consecutive years (1997–1998) to identify economically feasible intercropping systems. The result of experiment was statistically analyzed using total monetary value of the system and economic yield of each component crop. Moreover, the land equivalent ratio of each intercropping system was calculated. Intercropping of potato with maize in 2:1 and 1:1 (potato: maize) row arrangements were found superior and recommended for potato production around Adet (Tesfaye et al., 2008).

Harvesting Time

In the absence of storage technologies for ware and seed potato, farmers keep potato harvest in the ground for a long period in Ethiopia. This reduces tuber yield significantly. A study on extended harvesting period in Alemaya revealed that yield of marketable tubers was reduced by 60% when tubers were harvested at 210 days after planting as compared to a harvest at 120 days (Berga, 1984). Similarly, Gebremedhin (1987) reported significant yield reductions (70–100%) as harvesting was delayed from about 125 days to 230 days after planting at Holetta.

C Crop Protection

Insect pest of potato

Numerous general insect pest surveys have been conducted in the last three decades (Crowe et al., 1977, as cited by Bayeh and Tadesse, 1994). The insect pests identified were the following: Agrotis spp. and Euxoa spp (cutworms), Dorylus spp (Gojam red ant), Epilachanahirta (potato epilacha), Lagriavillosa (metallic leaf beetle), Phthoruimaea operculella (potato tubermoth),Myzuspersicae (green peach aphid), and Macrosiphum euphorbiae (potato aphids). Of these, potato tuber moth (PTM), cutworms, and aphids were the most important. Research has been made to inform management options against these economically important insect pests. Many survey reports indicated that PTM was known to damage potato only in the warmer areas, though major production areas mainly cover the highlands. Monitoring of PTM was conducted using PTM sex pheromone trap at Holetta. The result showed that the peak months were January, February, and June. Unlike the field situation, monitoring in the store showed no obvious peak record (Bayeh and Tadesse, 1994).

Aphids in potato, though, were more important as vectors of virus diseases than as pests.

Monitoring work was conducted using yellow water traps at Holetta, and during the monitoring different aphid species were recorded. The peak months were January, April, and November–December. The dominant species were Brassica aphids, green peach aphids, and potato aphids (Bayeh and Tadesse, 1994).In this work an attempt was made to correlate the population fluctuation with some abiotic factors, temperature, (minimum and maximum temperature in °C), rainfall (mm), and wind speed (km/h). The result showed that rain fall and minimum temperature had negative effects, whereas the influence of the other two factors was not significant.

Potato diseases

Potato suffers from a wide range of leaf, stem, and tuber diseases. A number of pathological activities have been done in the last decades: since 1989, 11 fungal, three bacterial, six viral, and one mycoplasma diseases have been recorded. Among these, LB, followed by bacterial wilt (BW), potato leaf roll virus, and potato virus Y (PVY) were the most important diseases. LB was widely distributed where the crop is grown under rainfed conditions (Bekele and Yayinu, 1994). In this report, BW was detected and found restricted to the mid and low altitudes. Currently, however, it has also been recorded in high altitudes (>2400 masl);

virus diseases were more prevalent in the mid-altitudes than in higher. Studies on host-plant resistance, loss assessment, cultural control measures, and integrated management have been conducted on many diseases.

Promising results have been obtained. Potato LB caused yield losses of 34– 97.5% at Holetta. Race analysis of Phytophothera infestans was performed at Holetta and Race 1,2,3,4, and 6 were identified. However, R2 and R3 were found to be highly prevalent (Bekele and Yaynu, 1994). Race identification has been carried out for BW and only Race 3 was recorded from different farms (Yaynu and Korobko, 1986). Results of chemical control trials indicated that a fungicide (Ridomil MZ 63.5% WP) containing Mancozeb and Metalaxyl was very effective in controlling LB (Bekele and Yayinu, 1994)

D Seed Potato Production

Shortage of quality seed tubers of improved cultivars is one important limiting factor to potato productivity and production. Past research experiences indicated that there is a good prospect for producing better quality seed potato on farmers' field in collaboration with other stakeholders. Currently, few formal organizations are engaged in potato seed production as a business. However, informal seed multiplication programs conducted by different agricultural research centers and other partner organizations were effective in disseminating improved potato varieties to farmers covering about 22% (Hirpa et al., 2007). To provide disease-free planting materials, a number of research activities have been conducted. Some rapid multiplication techniques (RMT, e.g., stem cutting and aeroponics) were evaluated under local conditions. Tuber yield increased

with increasing number of stem cuttings per hill from 1 to 3 and with closer spacing. Results revealed that the rooting abilities of stem cuttings differed with cultivar and media; fine sand was found to be the best locally available medium (Berga et al., 1994).Currently, millions of minitubers are under rapid multiplication for experimental and for pre-basic in our tissue culture laboratories and aeroponics facilities at Bahirdar and Holetta (Fig. 1). The conventional multiplication rate (1:3) of potato was promoted to very high rate (1: 30) by RMT.

E Potato Storage

Since potato tuber is a living botanical organ, it loses weight and quality during storage. Ethiopia lacks proper storage facilities, and farmers are forced to sell their potato harvest at low prices during harvesting and buy seed tubers at high prices during planting. However, farmers are aware of the new seed storage technology—that is, diffused light store (DLS) (Fig. 2). Practical training was given to farmers in different part of the country. Currently, 87% of the central part and 25% in the north and west are using DLS to store their improved potato variety seed (Agajie et al., 2008). Generally, better quality seed tubers are obtained with storage in DLS than in traditional dark storage, and as a result, productivity of potato in Ethiopia increases.

F Demonstrations

Technology transfer is both a technical and nontechnical process, and it should be carried out in collaboration with stakeholders. The main objective of technology transfer is to improve peoples' welfare gradually and continuously. In Ethiopia, there are still some drawbacks of technology transfer such as inappropriate channels, applicability of the technology, and lack of integration. A number of potato technologies were promoted through participatory seed multiplication and scaling-up from production to utilization in different parts of the country. These promotional activities sought to facilitate the diffusion and adoption of potato technologies that will improve potato production. To transfer these new technologies, two phases of activities were facilitated. In the first phase, participatory seed multiplication was conducted over the last

10 years. At this stage, researchers, Farmers' Research Groups (FRG), development agents, subject matter specialists, development project workers, nongovernmental organizations, and other stakeholders were involved in planning, monitoring, and evaluation. This was to promote awareness on better adoption of new technologies and quality seed for further dissemination. In the second phase, before launching the actual activity, an inception workshop was held with all stakeholders. Researchers played a catalytic role. On the basis of group consensus, the seed, which is maintained during the evaluation and seed multiplication phase, was distributed to all members of the FRG. In this way the potato technologies are diffusing to potato farmers. Currently, potato farmers are using almost all components of the potato production package. Throughout the whole process of evaluation, seed multiplication, and scaling-up of improved

Technologies, participation of farmers and stakeholders was useful to promote the diffusion and adoption of improved technologies, knowledge, and skill of quality seed production, and postharvest handling. This established the farmer-to-farmer seed exchange and information dissemination system. In the process, a number of field days were organized to demonstrate the production, postharvest handling, and utilization of potato (Fig. 3). In general, technical backstopping and creating good public-private partnership and technology transfer system are the most important issues that need more attention.

CHAPTER THREE RESEARCH METHODOLGY

The information discussed in this section includes the research design, study population, the methodology that have been used in sampling and data collection, to insure validity and reliability of the information, and data analysis and interpretation:

3.1 Research Design

As the objectives of this study are to investigate the problems and prospect of potato production and marketing, exploratory and descriptive types were used. It is descriptive because the study is intended to portray accurately the characteristics and the current status of seed and ware potato production and also marketing. The general socioeconomic characteristics of the study group are described by age, source and size of income, level of education, family size, and religion. The study is exploratory as it investigates the socioeconomic situation of the subject under the study and formulates a more precise research problem and develop hypothesis regarding to seed and ware potato production and marketing.

Thus the nature of the study requires both primary data [which have been collected from selected respondent] and secondary data [from relevant office report & documents]. The study also required to use both quantitative and qualitative data collection techniques. The quantitative methods that employed in this study is simple statistics expressed in frequencies and percentages. In order to seek answers for the research questions and achieve the objectives of the study, qualitative research methods have been also used in this study. The study design of this paper from non-intervention studies a case study has been selected. A simple random sampling technique was used to select sites and draw samples of farmers for the study. They are selected because of its high potential for potato production and for its prominence in practicing farmer based potato seed tuber multiplication. Two focus group which were drawn from two kebeles (gendo

gemebella and doko yoyera) were selected based on their experience in farmer-based potato seed tuber multiplication, it also DAs, and woreda experts, women's and etc were selected as a key informant .a total of 100 household sampling was carried out considering two sampling frames of farmers: participants in potato seed producers (50) farmers (from two kebeles) were randomly taken from the group who were engaged in potato seed tuber Production and were considered adopters. In the same way, 50 ware potato producers (hereafter called nonparticipants) were randomly taken from total residents in the two kebeles by excluding seed tuber producers. Thus, 100 farmers (household) were selected randomly for the survey. Primary data necessary for quantitative analysis were collected from 100households by conducting a formal survey using structured interview scheduled from September to October 2013. A questionnaire was developed and pre-tested on 12 randomly selected farm households from two selected rural kebele before conducting the formal survey. The interviews and discussions were conducted in the local language (Gamugena) to ease communication. Primary data were also obtained through interviews cooperative leaders (5), Key informant (20) and project staff engaged in implementation (6), Traders (10), brokers (10) and consumers (50). Secondary data were acquired through literature review and collection of available statistics from the concerned office in both published and unpublished sources. The data were analyzed using Statistical methods such as mean, average, maximum, minimum and rural appraisal was a tool selected for the study.

3.2 Study Population

When presenting a descriptive research study report one must indentify not only the kind of data obtained but also the exact nature of its population. As per the information gathered from chencha district, the district has 41 rural kebeles and its population is estimated 145,750 where women constitute 52% of the population and the number of households is 18769. The large pool that comprises all my sampling element is all rural population in chencha district and the target population that have been studied were all household who produce seed and ware potato. The sampling unit of this study was household and its sampling frame was the list of farmers in chencha ministry of agriculture on respective kebeles.

3.3 Methods of data collection

Methods of data collection and analysis in social research depend very much on the nature of the topic of research. However, in the present study it is felt that

any single method is bound to have only a limited relevance in meeting the overall objectives of the study, hence different tools have been used to collect the data so as to develop a near accurate understanding of the topic of research. The main tool of data Collection [Techniques] that I have used for this study is the following:

Using available information.

It is retrieving the necessary information that is collected by others [chencha agricultural office and rural kebele office etc.]

Observation.

It was involving a systematically selecting, watching and recording of behaviour and characteristic related to the study with and without the participation of the researcher.

Interviewing

There were conducting a face to face oral questioning of selected respondent and the key informant by using questionnaires and check list.

Focus group discussions.

Four focus groups were established and the groups have 10-13 informants after these freely discussion were held on the issue of potato production and marketing and also the major problems that hinder the development of modern seed and ware potato production and marketing in the study area. In addition to the above tools case- studies were also used as a tool for data collection. The case – studies were studied on 2 seed potato producer.

3.4 Sampling Technique

In selecting of the sampling techniques for this study three important points have been seriously considered and attention were given these are : representative, adequate and drawing a representative 'PROPORTION" of the population. The categories of sampling procedures that used in this study were probabilistic and non probabilistic sampling methods. From probabilistic method Simple Random Sampling techniques were employed and the lottery method to pick the respondent to be included in the sample. Based on this technique first two kebeles were

selected out of 14 potato producer rural kebele and then from these two kebele 100 household respondent were selected and t interview were conducted using questioner. From non probabilistic sampling method purposive or judgement techniques were employed to. Based on these cooperative leaders (5), Key informant (20) and project staff engaged in implementation (6), Traders (10), brokers (10) and consumers (50) were selected. So the sample size for the present study was two hundred and one.

3.5 Sample Size Determination

Krejcie and Morgan (1970) have given a table in which no calculation is needed to determine the size of sample for this study, ***based on that table the sample size were 201.***

3.6 Data Analysis and interpretation

Following the completion of data collection, the data were analyzed using different quantitative and qualitative statistical procedures and methods. The important statistical measures that I? have used to summarize and categorize were Mean, Percentage, Frequency, Minimum and Maximum.

3.7 Validity and Reliability

Reliability and Validity of the data means the consistency and the truthfulness of the data. These ensured by using reliable, valid and objectively usable tools. ***A*** *valid, reliable and usable tool ensures quality data. The validity of the data gathered through questioner or schedules in this study improved considerably by making the language of the questions unambiguous and also by selecting respondents who possess desired information and are likely to be keen to respondent conscientiously and objectively. The reliability of the responses to the questions of this study was inferred by a second administration of the tool and then comparing the questions with those the first.*

CHAPTER FOUR

4. DESCRIPTION OF THE STUDY AREA

Chencha woreda is about 540 km south west of Addis Ababa. The woreda is divided into 45 rural kebeles and 5 urban kebeles. The woreda had a total population of 145,750 persons of which 52.8% are female. The altitude of the woreda ranges 1800 - 3,380 meters above sea level. Temperature ranges from 1o°C up to 26.9°C. The mean annual rainfall ranges 1,000–1,400 mm. The rainfall pattern is usually bimodal: January–June for belg season and June–October for meher season. The potato-based system is found in all most parts of woreda (MOA, 2009). Chencha woreda is located in Gamogofa zone of the south National Regional State (SNNPR). The total population of the woreda is estimated to be 149,449, with an average family size of six people per household.). The average landholding size is 0.74 ha per person. The woreda is divided into three major agro-ecological zones: kola, woinadega, and dega. Chencha woreda is one of the 15 chronically food insecure woredas of SNNR. The major crops grown in the woreda are barely, wheat, peas and beans but Potato is one of the widely cultivated food crops in chencha woreda. Even though potato is grown every where the productivity is very low which is about 8 tons per hectare but played a key role in food security and income sources of the smallholder farmers in the study area. The major constraints that hinder the development of potato production and marketing are lack of sufficient quality seed, pest and diseases intensification and storage problem. Unless and otherwise these problem solved the expansion and development of potato production is under questions.

CHAPTER FIVE

5. RESULT AND DISCUSSION

In this chapter the finding of the study are discussed in detail based on the result obtained through household interviews [100 farmers from two rural kebeles of which 50 of them who utilized fertilizer, improved, high yield and late blight resistant potato varieties and the rest 50 farmers who have not utilized the above input but applied manure, Another 101 people of the two groups from two rural kebeles and key informant discussion with kebele leaders, development agents, and Chencha district agricultural experts was made. Moreover, the household characteristics and secondary data [agronomy reports] were also discussed and analyzed accordingly.

5.1 Socio Economic and Demographic Characteristics of the Respondents

In this research, sex, age, marital status, level of education, family size, family income, landholding, housing condition, etc. were found to be important variables that affect the life of the farmers. Detailed information on each variable is described as follows.

5.1.1 Age and Sex of the Respondents

Age and sex were among the major characteristics that were given due attention during this study in order to investigate the role and participation of women's towards potato production system, and age factor on the extent of acceptances and adapting improved potato production technology. Having understood these characteristics, the age and sex of the respondent were studied and the responses were summarized in the table below:

Table5. 1. Frequency and Percentage Distribution of Age and Sex of the Respondent

Age Group	Sex				Total	
	Male		Female		No	%
	No	%	No	%		
20 - 26	10	1o	4	4	14	14
27 -32	8	8	1	1	9	9
33 - 38	12	12	2	2	14	14

39 – 44	15	15	4	4	19	19
45 -50	30	30	3	3	33	33
51 - 60	6	6	-	-	6	6
Above 60	4	4	1	1	5	5
Total	85	85	15	15	100	100

Sources: own field survey 2014

As shown in Table 5.1, it was found that the overwhelming majority which was 85% of the respondents were male. Based on this, one can easily say that in the study area women's did not have an access to agricultural technologies and trainings so their participation were very less. The age composition shown in the table illustrated that 33% of the respondents were between 45-50, 19% were age between 39 – 44, 14% were age between 20 – 26 & 33 – 38, 9% were age between 27 - 32 and 11% were age above 51. From these 63% of the respondent were the age above 40 which most of them were uneducated and resist to new changes and technologies.

5.1.2 Level of Education of the respondents

One of the measures that contribute to the development of modern potato farming system and ensure the adoption, expansion and sustainability of agricultural technologies is the ability of farmers to read, write and perform the technologies technical requirement. Moreover, although it is not the only factor, a lack of education is believed to be one of the major factors for not to be successful in agriculture sector. Thus the respondents' level of education was examined and the following were found out:

Table5. 2 Respondents Level of Education

Level of education	Sex				Total	
	Male		Female		No	%
	No	%	N0	%		
Illiterate	2o	20	15	15	35	35
Basic literacy no formal education	36	36	-	-	36	36
Formal primary education (1 – 4)	20	20	-	--	20	20
Formal primary education (5-8)	6	6	-	-	6	6
Grade 9 – 12	3	3	-	-	3	3
Above Grade 12	-	-	-	-	- -	-
Total	85	85	15	15	100	100

Source: own field survey 2o14

In order to get vivid picture of the respondent level of education, detail categories were made and summarised in the table 5.2. As it clearly shown in the table, the percentage of illiterate was very high (35%) among the respondents while the proportion of the respondents who didn't pass through formal education was 36%, and those that were in primary school were about 26 %. Quite a big proportion of the total respondents (91%) were school dropout while only 9% of the respondents were joining high school (9 – 12). Discussion with the focus group revealed that lower value and lower perception to education in general and to the girls education in particular, was caused by poverty, which is the major cause for dropping out of the school. Few also reported that as their families were struggling to win bread for the family, they did not have spare time to go to school. During the focus group discussion it was also raised that level of education affect the expansion, dissemination and sustainability of improved potato technology.

5.1.3 Marital Status of the Respondents

Marital status was taken as one of the characteristics to be examined in this study, and questions were raised to the selected respondents about their marital status (Table 5.3).

Table5. 3 marital status of the respondent

Marital status	***Sex***				***Total***	
	Male		***Female***		***No***	***%***
	No	***%***	***No***	***%***		
Never married / single	***12***	***12***	***-***	***-***	***12***	***12***
Currently married	73	73	7	7	80	80
Divorced	-	-	3	3	3	3
Widowed	-	-	5	5	5	5
Total	85	85	15	15	100	100

Source: own field survey 2014

As it is depicted in the above table 80% of the respondents have got married and only 12% were single. Five percent of the respondents were widowed and 3% were divorced. This shows that there is no shortage of family labour to perform the required techniques.

1.1.4 Family Size and Family Members Age Group

One of the characteristics that was assessed in this study was family size. This was considered in this study since the number of family labour force affects the production of potato and also the income obtained from this product. The reaction of the respondents in this regard was the following:

Table 5.4 Family Size Of The Respondents

Family size			Age Categories Of The Respondent Family Member					
			Age Below 15		Age Between 15-18		Age between 19-60	
Family size	No	%	No	%	No	%	No	%
1-3	6	6	3	3	2	2	1	1
4-6	21	21	7	7	9	9	5	5
7-10	60	60	15	15	19	19	26	26
Above 10	13	13	4	4	5	5	4	4
Total			29	29	35	35	36	36

Source : Own Field Survey

As Table 5.4shows 60% of the respondents have a family size of 7-10, and 21% of the respondents have a family size between 4-6. Only 6% of the respondents have small family size (1-3). In addition to these, 71% of the respondents family member have an age above 15 which shows that the population in farming operation were great and helpful for intensive modern potato farming system.

5.2 production and productivity

One of the objectives of this study was to assess and investigate the production and productivity of seed and ware potato in the study area for this has prominent importance for the analysis of problems and prospect of potato production system. So the selected respondents production and productivity were examined through interviews, and by collecting yield assessment samples from the respondent seed potato fields in meher (July-December) 2013 cropping season. from the agronomy department of the Ministry of Agriculture, chencha district. The result found is indicated below

5.2.1 Seed Potato Production and Productivity

Shortage of quality seed tubers of improved cultivars is one important limiting factor to potato productivity and production. And also quality of potato seed is a key factor in profitable potato production. In order to solve the shortage of quality potato seed that are late blight resistant and high yield varieties, the Chencha district Ministry of Agriculture and Vita (NGOs) together form and established 6 farmers group who grew improved potato seeds in the year of 2012. The strategy was proposed as a means to overcome the shortage of high quality seed potato in Chencha, aiming to increase significantly potato yields and to contribute to improve smallholder income and food security. The strategy concentrates their efforts in producing large amount of high quality seed potato in 3 generations. It also contemplates parallel investments at the farm level in order to improve farmers 'seed management and to generate a sustainable demand for high quality seed. A key assumption of the strategy is to have a profitable multiplication of quality seed from certified or 3G seed. The aim is for small seed multipliers to produce G4 or G5 that can be used in ware potato production producing high yields among the ware potato producers that invest in this high quality seed.

Figure5.1 A WOMEN FARMER ON HER IMPROVED AND HIGH YIELD POTATO FARM PLOT

Based on these strategies the following main activities were performed

- *Promotion of diffused light stores and awareness rising in the importance of good seed storage.*

Figure-5.2 PROMOTION OF DIFFUSED LIGHT STORES PROVIDED TO VITA (NGO) BENEFICIARIES

- *Promotion and distribution of clean seed to smallholder potato seed growers*

- *Promoting the diffusion and adoption of new high yielding and disease resistant varieties;*

- *Capacity building and training of farmers and technical staff of all stake holders*

- ***Figure-5.3 TRAINING OF FARMERS AND TECHNICAL STAFF OF MAIN STAKE HOLDERS ON IMPROVED SEED AND WARE POTATO PRODUCTINON AND MARKETING***

Basic data about seed potato producer and related information were found from the Ministry of Agriculture of Chencha district and Vita (NGOs) Office as indicated below.

Table 5.5 Basic data on improved, high yield, and late blight resistant potato seed production

Variables	Unit	2011		2012		2013		
		Belge season	Meher season	Belge season	Meher season	Belge season	Meher season	Total
Smallholder potato seed growers	Numbers	60	60	120	120	160	160	680
Provision of improved clean potato seed Jallenne Gudenae	Quintal Quintal	280 20	280 20	600 -	600 -	800 -	800 -	3360 40
Area covered	Hectares	15	15	30	30	40	40	170
DLS construction	Numbers	60	60	120	120	160	160	680

Source: chencha district MOA & Vita (NGOs)

Based on the response of selected respondents (50 seed potato producer) , data regarding the seed potato production in three consecutive years (2011 – 2013) was gathered and summarized in table below:

Table 5.6 : seed potato production

No	Name of Selected Respondent	Year 2011				Year 2012				Year 2013			
		Area covered by seed potato (hectares)		Production (Kg)		Area covered by seed potato (hectares)		Production (Kg)		Area covered by seed potato (hectares)		Production (Kg)	
		Jan-June	July-December	Jan-June	July-December	Jan-June	July-December	Jan-June	July-December	Jan-June	July-December	Jan-June	July-December
50	See appendix												
	Total	13	3.5	449,200	104,700	16.25	5.0	484,800	122,500	16.25	10.75	411,800	230,200
	PRODUCTIVTY			34,554	29,914			29,834	245			25,342	21,414

Source: Own Field Survey2014

As the above table depicts the total production found from 50 respondents of seed potato multipliers in the year of 2011 belge season were 449,200 Kg from 13 hectares of land , which gives productivity on this season 34,554 Kg per hectare. But during the same year in meher season it was found 104,700 Kg from 3.5 hectares and the productivity were 29,914Kg , indicating that the production and productivity on belge season was much higher. According to the respondents reaction the reasons for better yield and productivity in belge season was because of suitable temperature during this period (60% of the annual rainfall and an average 32 mm per week is found in belge season which is adequate supply of water in a balanced distribution, but in meher season 40 % the annual rainfall and an average 23mm per week found which is no adequate and not evenly distributed, in addition to these the average daily temperature in belg

*season is lies between **15—20°c** but in meher season the average daily temperature is lies between **8—10°c** the variation of temperature and rainfall in two potato cropping season is one of the critical factor for better production and productivity in belge season (January _ June) in the study area. During the year 2012, the productions found in belge were 484800 Kg from 16.25 hec. and its productivity was 29,834Kg, during mehear season of the same year production was found 122,500 Kg from 3.5hec. and its productivity was 35,000 Kg/ hac. In the year of 2013 belge season seed potato production found 4118 Kg .from 16.25 hac. and its productivity were 25,342 Kg /hec, But in mehear season on the same year it was found 230,200 Kg of seed potato production from 10.75 hectares of land which gives the productivities to 21,414 Kg per hectares. The total production of seed potato that produced by the respondent from the year 2011-2013 [in three consequent years] were 1,803,200 Kg by cultivating 64.70 hectare which gives the average productivity of seed potato were 278,700 Kg.*

Based on the sample taken in the field during mehear season in 2013 the result that was found in the study area on seed potato production and productivity were the following:

Table 5.7 Seed potato yield assessment based on sample taken

NO	RESPONDENT NAME WHERE THE SAMPL TAKEN	TOTAL AREA CULTIVATED FOR SEED POTATO Hectares	SAMPLE AREA AND NUMBER		YIELD FROM SAMPLE AREA(kg)	YIELD PER HECTARE(kg)
			NUMBER	SIZE M2		
10	See appendix	2.75	30	120	334.2	27,850

SOURCE OWN FIELD SURVEY Dec, 2013

The productivity of seed potato as indicated on Table 5.7 was 27,850Kg per hectare based on physical yield assessment in terms of 30 samples taken from 10

respondents of seed multiplier. But the average productivity found based on the information given from 50 respondents was 29,910Kg per hectare in belge season and 25,276Kg per hectare in meher season. So in the study area the productivity of improved late blight resistant and high yield seed potato were relatively the same from both sources that are 27,850Kg per hectare. The total production of seed potato in the three consecutive years were 553,900 Kg in the year of 2011, 607,300Kg in the year of 2012, and 6420,00Kg in 2013. The growth rate of seed potato production 9.6 % in 2012 and 5.7 % in 2013 was minimum. Generally one can conclude that as explained in the above two tables maximum yield of seed potato per hectare was 35,500 while the minimum was 17,500kg / hectare.

Shortage of quality seed tubers of improved cultivars is one important limiting factor to potato productivity and production. The last three years experience indicated that there is a good prospect for producing better quality seed potato on farmers 'field in collaboration with other stakeholders. Currently, few formal private initiatives are engaged in potato seed production as a business. However, informal seed multiplication programs conducted by different NGOs and agricultural office and other partner organizations were effective in disseminating improved potato varieties to farmers.

5.2.2 Ware Potato Production and Productivity

Based on the information found from 50 randomly selected ware potato producer from two kebeles, and yield assessment sample taken from 10 selected respondents the production and productivity of ware potato were the following:

Table5. 8 production and productivity of ware potato

No	Name of Selected Respondent	Year 2011				Year 2012				Year 2013			
		Area covered by seed potato (Hectares)		Production (Kg)		Area covered by seed potato (Hectares)		Production (Kg)		Area covered by seed potato (Hectares)		Production (Kg)	
		Jan-June	July - Dec.	Jan-June	July - Dec.	Jan-June	July-Dec.	Jan-June	July-Dec.	Jan-June	July-Dec.	Jan-June	July-Dec.
	Total	3.87	3.675	49,130	19,360	13.704	5.651	132,360	43,800	7.992	6.98	54,930	41,160
	PRODUCTIVTY OF WARE POTATO			12,695	5,268			9,658	7,751			6,873	5,897
	AVERAGE LAND [FARM] SIZE PER HOUSEHOLD	0.0774	0.0734			0.274	0.113			0.159	0.139		

Source: Own Field Survey2014

As Table5.8 depicts the total production that was found from 50 respondents of Ware potato producer in the year of 2011 belge season (January to June) were 49,130 Kg from 3.87 hectares of land, which gave productivity on this season 12,695 Kg per hectare, but during the same year in meher season (July to December) it was found 19,360 Kg from 3.67 hectares and the productivity were 5,268Kg. In the year of 2012 the production in belge season was found 132,360kg from 13.704 hectares of land, which gave productivity 9,658 kg, but in meher season the production was 43,800kg from 5.651 hectares of land, which gave productivity on this season 7,751kg/hectare. In the year of 2013 on belge season the production was 54,930kg from 7.992 hectare of land, which gave productivity 6,873 kg/hectare but on meher season on the same year the production was

41,160kg from 6.98 hectare of land, which gave the productivity 5897kg per hectare. As the data in table 5.8 shown that the production of ware potato in belge season was very much better than in meher season this is because as the reaction of the respondent, was suitable temperature and rainfall during this period. Based on the reaction of the respondent the total ware potato production produced from the year 2011 to 2013 was 340,700 kg by cultivating 41.87 hectares of land, which gave the average productivity of ware potato in the study area was 8,140 kg per hectare. In addition to these the data on the above table shown as the average potato farm per household is 0.1394 hectare.

Based on the sample taken on seed potato production and productivity in the field during mehear season 2013 the following result was found:

Table5. 9 Ware potato yield assessment based on sample taken (Make this table clear.To what does the third row is referring to? Not clear check also your data

NO	RESPONDENT NAME WHERE THE SAMPL TAKEN	TOTAL AREA CULTIVATED FOR SEED POTATO	SAMPLE AREA AND NUMBER		YIELD FOUND ON 30 SAMPLES AREA [120 m2] Kg	YIELD FOUND PER HECTARE Kg
			NUMBER	Area m2		
10	SEE ON APPENDIX	1.75 Hectares	30	120m2	89.56	7,463 Kg

SOURCE OWN FIELD SURVEY Dec, 2013

The productivity of ware potato as table 5.9 above describes were 7,464 Kg per hectar based on physical yield assessment in terms of 30 samples taken from 10 respondent of ware potato producer. But the average productivity found based on the information given from 50 respondents in table 5.8 discussion part were 8,140 Kg per hectare. So in the study area the productivity of ware potato from both sources show that there is some difference which was [8,140-7,464] 946 Kg per hectare. Based on sample taken in the field from 10 farmers [respondent] shows as the productivity of ware potato in the study area was 7,463 Kg per hectare.

5.3 DEMAND AND SUPPLY ANALYSIS OF POTATO PRODUCT

Both Demand [Consumption] and Supply [Production] of seed potato [improved, bacteria wilt resistant and high yield varieties] and ware potato product are one of the main objectives and variable of this study and hence it was investigated and summarized in the following way:

5.3.1 DEMAND F OR IMPROVED HIGH QUALITY SEED POTATO AND WARE POTATO IN THE STUDY AREA

A - SEED POTATO DEMAND ANALYSIS

The estimation of the demand for seed potato was started from the annual requirement of seed needed to plant the total area devoted to potato production. To estimate the annual requirement in the study area the total area of potato production used collected from the last agricultural reports (MOA, 2013 chencha) and the average rate of seed used per hectare in chencha, which the CIP project a reported in the recent two years. From the same farm level information, the paper estimated the percentage of farmers that replaced their seed stock with off farm sources and the average numbers of seasons that the same seed was used before replacement (among those who replaced seed).

The next step was to estimate the annual demand for new seed in each farmer. The demand of new seed was estimated by multiplying the annual requirement of seed potato by the percentage of farmers that replaced seed and by dividing this product by the number of years that took to replace old seed with new seed (the number of seasons of seed used plus one is divided by two seasons . Although this annual demand of new seed may represent the maximum quantity of seed that can potentially be sourced with high quality seed, a better estimation of the lower bound of the demand for high quality seed was calculated using the average proportion of new seed that was used high quality sources (from trained seed multipliers in the study area). This allows us to estimate the minimum quantity of high quality seed that would be expected to be demanded by potato producers in the study area. With existing information it have been estimated that the demand for high quality seed is at least per year were as follows

According to the information of Ministry of agriculture in chencha district the average total area devoted to potato production per year in two cropping season was 2602.04 hectares of land in Belge season and 1170.92 hectares of land in Meher season, which in total was 3722.96 hectares of land per year is under potato production.

Each hectare of land need 2,000Kg of high quality, late blight resistant, high yield and improved variety of seed potato. 18666 HH farmers cultivated 3722.96 hectares of potato farm land per year in two seasons. So based on the result found 50% of the respondents were more likely to participate on modern potato technology. The average potato farm size based on the respondents was 0.1394 hectares (as table 5.8 explained) and this multiplied by 9333 households (50% of

the total households) gives you 1301.02 hectares of land needs improved, late blight resistant and high yield variety of seed potato.

- ***The total demand of high quality, late blight resistant, high yield and improved variety of seed potato in the year of 2014 is 1301.02 hectares x 2000Kg = 2,602,040 Kg.***

B- WARE POTATO DEMAND ANALYSIS

- *The total population of chencha rural and urban in the year of 2013 based on the information collected from MOA (Ministry of Agriculture) chencha are 140,590*
- *The average consumption of potato per year per head 250 Kg*
- ***So the total demand for ware potato in the year of 2014 is estimated – total population 140,590 x consumption per head 250 Kg = 35,147,500 Kg***

5.3.2 SUPPLY FOR IMPROVED HIGH QUALITY SEED POTATO AND WARE POTATO IN THE STUDY AREA

A- SUPPLY FOR IMPROVED HIGH QUALITY SEED POTATO

- *The average high quality seed potato and late blight resistant varieties yield that was found per hectare* ***was 27,850Kg.***
- ***The number of seed potato multipliers in the year of 2013 were 320 and area covered by seed potato was 80 hectares***
- *Growing rate seed multiplier and area in the study area found 9.6 %.*

❖ ***Based on the above study result the supply of high quality, late blight resistant varieties seed potato in the year 2014 were 278.50kg x 80 hectares =2,228,000kg + 9.6% = 2,441,888kg***

- ***Based on this analysis it is advisable that the number of high quality seed potato multipliers and area cultivated should not exceed from 320 seed potato multipliers and 80 hectares.***

B - SUPPLY FOR WARE POTATO

The total demand for ware potato in the year of 2014 was estimated – total population 140,590 x consumption per head 250Kg = 35,147,500Kg

The supply of ware potato produced in the year of 2013 were 18666 household farmers cultivated 3722.96 hectares of potato farm land per year in two seasons. The productivity of ware potato were 8140kg per hectare. So based on this the annual supply of ware potato in the study area in the year of 2014 will be 3722.96 hectares of potato farm land per in two seasons x the productivity of ware potato were 8140Kg per hectare = 30,304,800Kg.

Based on the above demand and supply for potato product result the analysis was summarized on the following tables:

TABLE 5.10 DEMAND & SUPPLY ANALYSIS OF POTATO IN 2014

ITEMS	***DEMAND***	***SUPPLY***	***GAP***
SEED POTATO	***2,602,040 Kg***	***2,441,888 Kg***	***Qd>Qs by 160,152 Kg***
WARE POTATO	***35,147,500 Kg***	***30,304,800 Kg***	***Qd > Qs by 4,942,700Kg***

SOURCE: OWN FIELD SURVEY Jan, 2014s

5.4 COST BENEFIT ANALYSIS OF SEED AND WARE POTATO PRODUCTION [PROFITABILITY]

Under this title the cost benefit analysis of producing seed and ware potato per hectare was investigated and summarized first by collecting data from 100 randomly selected respondent and applying discounted rate of net present value ***[NPV], payback period, and cost benefit ratio [CBR]*** *the result were the following:*

Table 5.11 Revenue and Cost analysis on producing high quality seed potato per Hectare

VARIABLE THAT REQUIRED COST PER HECTARE	***AMOUNT OF LABOUR REQUIRED PER HECTARE Person /Days***	***UNIT COST IN EURO***	***COST PER HECTARE IN EURO***	***VARIABLES WHERE THE REVENUE COME FROM IN EURO***	***TOTAL REVENUE IN EURO***
LABOUR COST *Clearing* *3x ploughing & hill-up* *[ridging]* *Planting* *Fertilizing* *Weeding [3x]* *Pest & diseases control* *Harvesting* *Grading* *Storing*	 *20* *100* *50* *50* *25* *10* *35* *12.5* *10*	 *1* *1* *1* *1* *1* *1* *1* *1* *1*	 *20* *100* *50* *50* *25* *10* *35* *12.5* *10*	*Assumption* *Average production of seed potato based on the study 27,870 Kg.* *Out of this 10% for home consumption, 10% for his own seed and 5% for his relatives.* *So the net seed potato for sale was 75% which was 20,900 Kg.* *The price seed potato per Kg is 0.26 EURO* *Total revenue =20900 Kg x 0.26 EURO*	*5434 EURO*
INPUT COST *Fertilizer 195kg DAP* *and 165kg of UREA* *Pesticides & insecticide* *Store DLS [8X10]*		*0.022/Kg* *0.36/KG* *15.87/LITTER*	*42.39* *60.97* *15.87*		
TRANSPORT COST *From farm land to store*			*87.00*		
TOTAL COST PER HECTARE			***518.73 EURO***	***Total revenue***	***5434 EURO***

Source Own survey Jan, 2014

***As** table above shows that producing of seed potato by farmers were the most and best profitable farming practice ever had in any other agricultural practice. So potato is a buried treasure for farmers because they found 400% profit earn.*

Table5. 12 Revenue and Cost analysis on producing ware potato per Hectare using inputs and necessary technologies.

VARIABLE THAT REQUIRED COST PER HECTARE	***AMOUNT OF LABOUR REQUIRED PER HECTARE Person /Days***	***UNIT COST IN EURO***	***COST PER HECTARE IN EURO***	***VARIABLES WHERE THE REVENUE COME FROM IN EURO***	***TOTAL REVENUE IN EURO***
LABOUR COST				*Assumption*	
Clearing	*20*	*1*	*20*	*Average*	
3x ploughing & hill-up [ridging]	*100*	*1*	*100*	*production of ware potato*	
Planting	*50*	*1*	*50*	*based on the*	
Fertilizing	*50*	*1*	*50*	*study 20,500Kg.*	
Weeding [3x]	*25*	*1*	*25*	*Out of this 10%*	
Pest & diseases	*10*	*1*	*10*	*for home*	
control	*35*	*1*	*35*	*consumption,*	
Harvesting	*12.5*	*1*	*12.5*	*10% for his own*	
Grading	*10*	*1*	*10*	*seed and 5% for*	
Storing	--	--	--	*his relatives.*	
				So the net seed potato for sale were 75% which was 15,375 Kg. The price of ware potato per Kg is 4.00 birr Total revenue =15,375Kg x 0.17 4 EURO= 2675.25 EURO	*2675.25 EURO*

INPUT COST *Fertilizer 195kg DAP and 165kg of UREA* *Pesticides & insecticide* *Store DLS [8X10]*			-- -- --		
TRANSPORT COST From farm land to store			*17.39*		
TOTAL			*289.13EURO* Per hectare		*2673.91 EURO*

Source: own survey jan,2014

As *table above shows that producing of ware potato by farmers were profitable farming practice ever had in any other agricultural practice so potato is a buried treasure for farmers which were 200% profit earn.*

5.4.1 FEASIBILITY STUDY OF SEED AND WARE POTATO PRODUCTION PROJECT AT SMALLHOLDER FARMERS LEVEL

Investigating the feasibility and the financial viability of seed potato production project at smallholder farmers level is one of the main concern of this study so using and applying NET PRESENT VALUE [NPV], INTERNAL RATE OF RETURN [IRR] and BENEFIT COST RATIO [BCR ***]*** *methods the following result were found :*

A USING DISCOUNT RATE NET PRESENT VALUE [NPV]

One the selection criteria for feasibility of the project in every sector are NPV WHICH the total benefits and costs of a project duly discounted. The selection criteria for the project are then that the discounted benefits should exceed the discounted costs. In other word the project is positive indicating that the investment in seed potato production is acceptable or feasible using these single criteria. But if discounted benefits are less than discounted costs then the project is not acceptable or feasible. In general any investment on seed and ware potato production by smallholder farmers with a NPV equal to or greater than zero is acceptable and feasible using this single criteria.

Formula of $NPV = \sum_{t(Bt-Ct)/(1+r)}^{n} t$

Where NPV is net present value

Bt is benefit got from the project through time

Ct is cost incurred to the project through time

r interest rate

t years [time]

2 selection criteria

If NPV ≥ ONE - The project is acceptable and feasible

If NPV < ONE - The project is not acceptable and not feasible

If $B\sum_{t=0}^{n} Bt/(1+r)t = \sum_{t=0}^{n} Ct/(1+r)t$ *- The project is alternate*

ASSUMPTION ARE IF A SMALLHOLDER FARMER INVEST IN ONE HECTARE OF LAND BY RENTING THE LAND FOR 10 YEARS BY CHANGING THE LAND SITE EVERY YEAR.

Table 5.13. NPV of the investment on seed potato production (on one Hectare)

PERIOD [YEARS]	*GROS SCOST [CAPITAL, OPERATION & PRODUCTION COST] [BIRR]*	*DISCOUNT FACTOR AT r = 10%*	*DISCOUNT COSTS WORTH AT 10 %*	*GROSS BENEFIT [BIRR]*	*DISCOUNT PRESENT VALUE FACTOR AT r = 10%*	*PRESENT VALUE AT 10 % [BIRR]*
0	*38,950*	*1*	*38950.00*	*0*	*1*	*0*
1	*28,950*	*0.909*	*26,315.55*	*125,400*	*0.909*	*113,988.60*
2	*18,950*	*0.826*	*15,652.70*	*125,400*	*0.826*	*103,580.40*
3	*18; 950*	*0.756*	*14.326.20*	*125,400*	*0.756*	*94,802.40*
4	*18,950*	*0.683*	*12,942.85*	*125,400*	*0.683*	*85,648.20*
5	*18,950*	*0.621*	*11,767.95*	*125,400*	*0.621*	*77,873.40*
6	*18,950*	*0.564*	*10,687.80*	*125,400*	*0.564*	*70,725.60*
7	*18,950*	*0.513*	*9,721.35*	*125,400*	*0.513*	*64,330.20*
8	*18,950*	*0.467*	*8,849.65*	*120,400*	*0.467*	*56,040.00*
9	*18,950*	*0.424*	*8,034.80*	*100,000*	*0.424*	*42,400.00*
10	*18,950*	*0.386*	*7,314.70*	*65,733*	*0.386*	*25,372.94*
TOTAL	*238,450.00*		*125613.55*	*1,163,933.00*		*734,761.74*

SOURCE: OWN SURVEY 2014 **92**

As table above illustrate

- *Net Present Worth At 10% = 734,761.74 – 125613.55 =* ***Birr 609,147.45***

SO BASED ON NPV SELECTION CRITERIA THAT IS

- **NPV ≥ ONE - The project is acceptable and feasible**
- ***Discounted benefits exceed the discounted costs [734,761.74 > 125613.55]***

B USING BENEFIT COST RATIO [BCR]

The benefit cost ratio of this study exuberates by using the following formula ***BCR*** *: dividing the discounted benefit by the discount costs we find benefit cost ratio, the selection criteria of the project is if the* ***BCR IS GREATER THAN ONE.***

$$\frac{\sum_{t=0}^{n} \frac{Bt}{(1+r)t}}{\sum_{t=0}^{n} \frac{Ct}{(1+r)t}}$$

SO IN THE ABOVE TABLE BASED ON *THE BCR SELECTION CRITERIA THE FOLLOWING RESULT WERE FOUND:*

$$= \frac{734{,}761.7}{125613.55}$$

which gives 5.85 , according to bcr criteria seed potato project for smallholder farmers is acceptable and feasible.

B) USING INTERNAL RATE OF TETURN [IRR] *the internal rate of return [irr] is the rate of discount at which the total discounted cash proceeds [benefits] expected from the project [seed potato producing] equals the total discounted cash outlays [costs] required by the investment. in other words, the IRR the rate which makes the NPV of the project equals to zero.*

The formula is

$$\sum_{t=0}^{n} \frac{Bt}{(1+r)t} = 0$$

The selection criteria of ***IRR is if IRR>r the project*** **is accepted, IRR < r reject the project, and if IRR ≥ r the project is indifferent**. *Based on this criteria the following result were found :*

TABLE 5.14 CALCULATION OF NPV AT VARIOUS DISCOUNT RATE FOR COMPUTING IRR OF THE PROJECT

years	Gross benefit	NPV AT 10 %	DISCOUNT FACTOR AT r = 40%	NPV AT 40 %	DISCOUNT FACTOR AT r = 45%	NPV AT 45 %
0	(-) 38,950	0	1	(-) 38,950	1	(-) 38,950
1	125,400	113,988.60	0.714	89,535.60	0.689	86,400.60
2	125,400	103,580.40	0.510	63,954.00	0.476	59,690.40
3	125,400	94,802.40	0.364	45,645.60	0.327	41,005.80
4	125,400	85,648.20	0.260	32,604.00	0.226	28,340.4
5	125,400	77,873.40	0.185	23,199.00	0.156	19,562.40
6	125,400	70,725.60	0.132	16552.80	0.107	13,417.80
7	125,400	64,330.20	0.094	11787.6	0.074	9,279.60
8	120,400	56,040.00	0.067	8,066.80	0.0511	6,140.40
9	100,000	42,400.00	0.048	4,800.00	0.035	3,500.00
10	65,733	25,372.94	0.034	2,234.92	0.024	1,577.59
	1,163,933.00	734,761.74		298,380.32		268,914.99

SOURCE own survey 20014 ONE YEAR

Based 0n the above table and the selection criteria of IRR producing of seed potato for smallholder farmers are feasible and acceptable project since the

result of IRR IS 57.67% which is greater than the discount rate and existing interest rate.

Generally seed potato producing project based on ***NPV, IRR ,BCR AND PAY BACK PERIOD THAT IS*** **ONE YEAR** ***IS ACCEPTABLE AND FEASIBLE.***

5.5 POTATO TECHNOLOGICAL INNOVATION

Assessing and examining of potato technological innovation is one of the main concern of this study. Here when I say Potato technological innovation, it comprise development and use of new, improved, high yield and LB resistant varieties, tools, equipments, storage facilities and improved management practices or techniques [irrigation, pest and diseases, agronomic practices]. Based on the reaction of the selected respondent, focus group discussion and secondary data the following result were found:

Table5.15 Adoption rate of improved potato technology

Techniques required on improved potato technology	***The required techniques***	***Actual performed***				***Reasons for the gap***	***Impact***
		Seed potato producer [50]		***Ware potato producer [50]***			
		No	***%***	***No***	***%***		
Use of selected Variety	***Certified*** Seed	***50***	***100***	***20***	***40***	****high cost of seed***	****Low production & productivity***
Site selection	***Potato planted 3 years ago, no1t swampy***	***33***	***66***	***11***	***22***	****low knowhow and skill***	****easily attacked by pest & diseases *Low production & productivity***
ploughing	***3x & loose the soil***	***42***	***84***	***5***	***10***	****takes more labor*** ****low knowhow and skill***	****abnormal tuber growth *intense weed n the farm***
spacing	***30x75 or20x65***	***38***	***76***	***6***	***12***	****takes more labor*low knowhow and skill***	****number & size of tuber decrease per plant and the tuber will not be marketable***

							size
Ridging	*At height of* 60cm	*31*	*62*	*1*	*2*	**takes more labor *low knowhow and skill*	**easily attacked by tuber moths & diseases *Low production & productivity*
Weeding& cultivation	*3x*	*26*	*52*	*15*	*30*	*" " "*	*"" ""*
Pest and disease management	*As it appears*	*44*	*88*	*0*	*0*	**high cost and not available*	*"" ""*
Fertilizer application	*As required*	*50* DAP, UREA	*100*	*50* manure	*100*		
Store construction & management	*DLS 2.5X4* FOR 4 TON	*50*	*100*	*0*	*0*	**high cost*	**sell their product at harvesting time with low price*
Producing marketable size potato		*30*	*60*	*10*	*20*	**low knowhow and skill*	**demand decreases*
planting date	*At the beginning or ending of rainy season[early planting recommended]*	*40*	*80*	*50*	*100*	*Delay of seed provision*	***Easily Attacked*** By pest and deseases
Sorting	*During planting 1x and storing 1x*	*25*	*50*	*12*	*24*	**low knowhow and skill*	**demand decreases*
optimum plant density,	*77,000—100,000/ha*	*50*	*100*	*9*	*18*	*"" ""*	*"" ""*
Depth of planting	*10-15cm*	*40*	*80*	23	46	**low knowhow and skill*	**poor germination*
soil & moisture conservation & proper drainage practices		*31*	*62*	*12*	*24*	**low knowhow and skill*	*Damage potato tuber*
Quality seed potato assurance practices		*11*	*22*	*0*	*0*	**low knowhow and skill*	**pest and diseases transmitted*

							& expand
AVERAGE ADOPTION RATE			***85.85%***		***32%***		

SOURCE: OWN SURVEY 2014

As table above depict the average adoption rate of potato technology to seed potato producer was 85.85% and to ware potato producer were 32% which shows low rate. Sustainability of dissemination of potato technology in the study area is under question.

Figure 5.4 ADOPTION OF POTATO TECHNOLOGY BY ONE OF SEED POTATO PRODUCER

Figure 5.5 ADOPTION OF POTATO TECHNOLOGY BY ONE OF SEED POTATO PRODUCER

5.6 THE ROLE OF POTATO TOWARDS FOOD SECURITY

5.6.1 INNOVATION TOWARDS PRODUCING QUALITY, HIGH YIELD AND LATE BLIGHT RESISTANT SEED AND WARE POTATO PRODUCT

Trainings, field days/open days, and technical meeting and support have increased the knowledge of the seed and ware potato growers. 26 farmers groups and 15 seed potato producer primary cooperatives were established and hence able to produce healthy seed potato in the study area. These were made by MOA, CIP PROJECT, VITA NGOs through training of more than 1234 farmers and providing healthy seed that were brought from Holleta research center which at the end resulted farmers themselves to become sources of seed of the improved varieties. Healthy seed of Jalene and Gudene that were grown in the year 2012 cropping season during the rainy season contributed in solving the problem of seed potato in the study area. The availability of healthy and high yield varieties much helped the communities in the study area to produce potato with high yield resulted food secured on critical period from the month of May to October and farmers can now produce food during the hunger period, thus making them food-

secured during the period. Farmers witnessed this by saying that, We have been able to increase our food stock in the month of May – October due to potato production.

5.7 THE ROLE OF SEED AND WARE POTATO PRODUCTION ON INCOME AND ASSET CREATION OF SMLLHODER FARMERS

In addition to food security, several farmers have increased income from the sale of potato seed and ware potato, which has helped to improve their living standard in all the study area. Farmers [each of seed producer] in GENDO GEMEBELLA AND DOKO YOYERA earned more than 26,489.00 birr per each in one cropping season in the [belge] year 2012. As the income of the farmers increase, most of them have saving accounts at different banks, indicated that potato production has improved household food security, nutrition quality, income diversification, and overall quality of living of the farmers who participated directly and indirectly through different communication. In general it was learned that through potato production with proper technical advice and backstopping, farmers are able to increase their income.

Figure 5.6 ONE OF SEED POTATO PRODUCER WHO ESTABLISH FLOOR MILL FOR HIS INCOME AND CREATE EMPLOYMENT FOR FOUR PERMONUNT LABOR

Table 5.16 Income and asset creation

VARIABLES	SEED POTATO MULTIPLIERS [PRODUCERS] [50]		WARE POTATO PRODUCERS [50]
	BEFOR THEY ENGAGE ON SEED MULTIPLIER	AFTER THEY ENGAGE ON SEED MULTIPLIER	
INCOME *400 - 1000 BIRR/ YEAR *1100-3000 *3001- 5000 *5001 - 10,000 *10,001 - 20,000 *ABOVE 20,000	65 % 10% 25% - - -	- - 8 % 55 % 21 % 16 %	74 % 9 % 17 %
ASSET CREATION *New house construction with corrugated iron sheet *better house furniture [sofa, control befae] *TV & DISH *sending their children to private school *BANK ACCOUNT *WATER PUMP		82 % 58 % 68 % 100 % 50 % 4 %	12 % 6 % - 20 % 6 % -
DIVERSFICATION			

*floor mill *shop *tea room *house construction for rent in chencha town	- - - -	2 % 12 % 18 % 12 %	- - - -

SOURCE – OWN SURVEY DEC, 2013

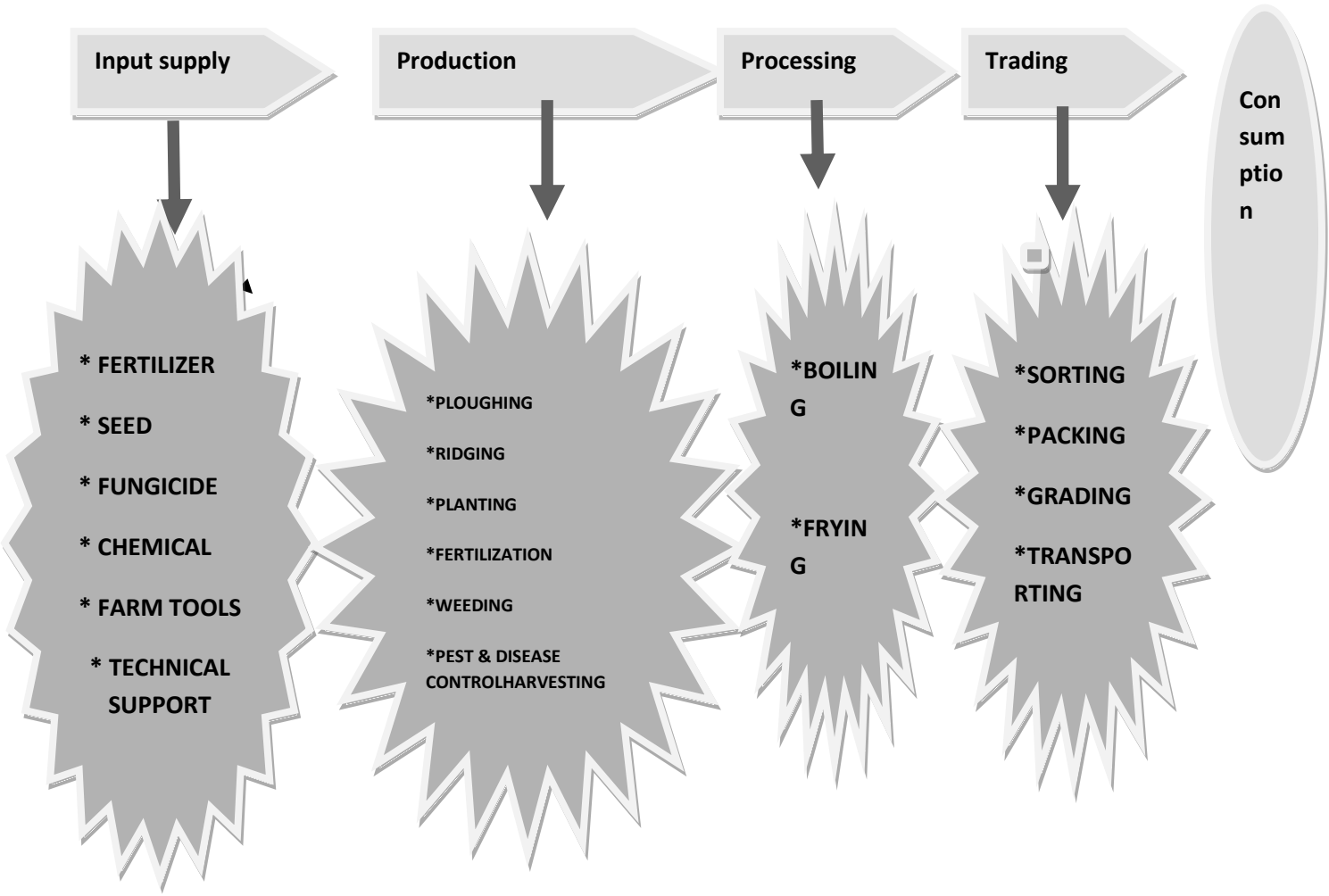
5.8 POTATO VALUE CHAIN ANALYSIS AND DEVELOPMENT

The other important variables that was assessed in the present study was the sequence of related business activities and functions from the provision of specific inputs for a seed and ware potato product to primary production, transformation, marketing and up to final consumption. Based on the information gotten from the respondent ***[selected interviewee, focus group, key informant, consumer, broker,]*** *the following result have found regarding to potato value chain analysis and development in the study:*

5.8.1 VALUE CHAIN ACTORS AND FUNCTION IN THE STUDY ARE: Value chain

Actors in the area classified owner of potato product, individuals or firms who exchange, transform the product and service providers. Based on the information of the respondents the primary actors in a potato value chain in the study area are seed and other input suppliers; farmers; traders; brokers; retailers; and consumers. Each of this actor adds value in the process of changing potato product [seed and ware]. According to the respondent the main process and the function performed by the chain actors are the following:

Figure5.7 Process and function in potato value chain in the study area



SOURCE: OWN FIELD SURVEY Dec, 2013

Table 5.17 summary of Value chain Actors and Function

POTATO FUNCTION	***ACTORS PERFORMING THE FUNCTION***
INPUT SUPPLY • ***fertilizer*** • **seed** • **fungicide** • **chemical** • **farm tools** • **technical support**	• *Cooperatives* • Farmers • MOA, NGO • MOA, NGO • MOA, NGO • MOA, NGO
PRODUCTION	• *Smallholder farmers*
PROCESSORS	• *Street vendors*
GRADING	• *Whole sellers, Retailers, farmers*
CONSUMPTION	• *Urban and rural residents* • Hospitals • Prisoners

SOURCE: FROM FOCUS GROUPS DISCUSSION DEC 2013 CHENCHA

5.8.1.1 - INPUT SUPPLIER

Based on the information found from selected respondents and focus group discussion 62% Potato farmers in the study area use their own local seed, 10% of them use improved varieties from potato seed producer, and the rest 28 % of them got seed from other farmers. Only about 33.7% of potato growers use fertilizer (DAP, UREA) because of its high price, and obtained the fertilizer only from cooperatives. The number of improved seed potato growers was 185.

5.8.1.2-POTATO PRODUCERS

*The next major potato value chain actors next to input supplier are seed and ware potato growers. Most of them in the study area are smallholder farmers having an average potato land size 0.136 hectares. The total number of potato growing farmers in chencha district according to the information found from MOA, in the year 2012 was 8234. This implies that 40 % of the household in the study area produce potato product for food and cash. Potato growers are the major actors who perform most of the value chain functions right from input supply up to post harvest handling and marketing. The major value chain functions that potato grower perform include *PLOUGHING, *RIDGING *PLANTING,*FERTILIZATION, *WEEDING, *PEST & DISEASE CONTROL, and HARVESTING. According to the respondent reaction the most difficult function is RIDGING, since it is labour intensive. Cropping system in the study area are totally Potato sole cropping and no one use intercropping.*

5.8.1.3 POST HARVEST HANDLING ACTIVITIES IN THE STUDY AREA

To get a clear picture on post harvest handling activities which is one of the main issues in this study a question were raised to the respondent their reaction was the following:

Table 5.18 Post harvest handling activities

S.NO	POST HARVEST HANDLING ACTIVITIES	ACTORS	REMARKS
1	*Sorting*	*Farmers*	• ***If potato is sold in farm gate all aforementioned activities are performed by the buyer***
2	*Grading*	*Farmers*	
3	*Packing*	*Farmers*	
4	*Storing*	*Farmers*	
5	*Transporting*	*Farmers*	• ***The producer transport their potato the nearby market using pack animals but seed potato producer sold his product in his store***
6	*Loading & unloading*	*Trader & broker*	
7	*Storing*	*Farmers*	•

SOURCE: OWN SURVEY DEC, 2013

After harvesting, potatoes are collected in sacks most of the time in 60 k.g. Most of the farmers use sacks and ground of their residential house as a potato store but seed potato producers have their own store called diffused light storage[DLS]

5.8.1.4 TRADERS AND BROKERS

Based on the data and information found from the respondent regarding to seed and ware potato sold in the study area were the following:

TABEL 5.19 POROPORTION OF POTATO GROWERS WHO SOLD THEIR POTATO THROUGH DIFFERENT CHANNELS

ACTORS	***SEED POTATO PRODUCERS*** N=50		***WARE POTATO PRODUCERS*** N = 50		***Total***
	NUMBER	***PERCENTAGE***	***NUMBER***	***PERCENTAGE***	
Trader	*2*	*4*	*16*	*32*	*36*
Broker	*3*	*6*	*8*	*16*	*22*
Consumers	*-*	*-*	*26*	*52*	*52*
Processors	*-*	*-*	*-*	*-*	*-*
Cooperatives	*-*	*-*	*-*	*-*	*-*
Ware potato growers THROUGH NGOs & MOA	*45*	*90*	*-*	*-*	**90% seed producer sold to ware potato growers.*

SOURCE: OWN SUREVY DEC, 2013

As table 5.19 shows that 36% of the potato growers sold their potato to trader, 22% of them sold to broker and 52% of ware potato producer sold to consumer. But here 90% of seed potato growers sold their product to ware potato producer through NGOs and or MOA.

5.8.1.5 PROCESSOR [POTATO PROCESSONG]

Potato is commonly consumed in the form of boiled and cooked meals in dishes or wot(hot sauce?) Recently, in the study area consuming potato chips become common.

5.8.1.6 POTATO RETAILER

Retailers are the key actors in potato value chain in the study area. They mostly buy from producers and sell to consumers, in chencha town market, doko mesho market, ezo town market and dorze town market. Sometimes they could buy from whole sellers. They, on average purchase 150k.g per week in chencha town.

Potato retailing activities undertaken for six month while the remaining is slack period with limited potato transaction.

Figure 5.8 POTATO RETAILER AT CHENCHA MARKET

5.8.1.7 POTATO CONSUMERS

About three types of potato consumers were identified: these are households, restaurants, and institution [such as hospitals, prisons, and AMU]. Overall the per capita potato consumption was 0.537 Kg per Day, at peak time and 0.137 Kg/day at slack periods.

TABLE 5.20 POTATO CONSUMPTION IN CHENCHA

INSTITUTION	***AMOUNT CONSUMED PER YEAR [TON PER INSTITUTION]***	***AMOUNT CONSUMED PER HEAD [Kg PER CAPITA]***
Household	***2.41***	***250kg/head/year***
Restaurant	***3.40***	
Prison	***12.60***	
Hospital	***38.0***	
AMU(Arbaminch University)	***64.0***	

SOURCE: COMPUTED FROM CONSUMER SURVEY

5.8.1.8 POTATO SUPPORT SERVICE PROVIDER

The key support service providers in the study area are agricultural office which provide service at input level, agricultural extension service that provides to farmers through development agent at production level and also provide advisory service, facilitates access to inputs and marketing and technical support in crop protection. . It was leant that the extension agents (Das and experts) do not give more attention to potato crops. NGOs [vita CIP PROJECT, world vision, kalehiwot church] provides inputs [improved seed potato] and trainings to farmers and technical persons.

5.8.1.9 VALUE CHAIN GOVERNANCE

The assessment made in the study area indicates that traders and brokers are the dominant in ware potato value chain actors that play facilitation role. In effect they govern the value chain and others chain actors subscribe to the rules set in the marketing process. The study shows as that the wholesaler assisted by brokers

is the key value chin governors. But in improved seed potato the key value chain governor is seed potato grower assisted by the agricultural office.

*The smallholder farmers are not organized and are not governing the value chain. Hence they are price takers and hardly negotiate the price due to fear of post harvest loss, in case the product is not sold. These conditions also create a great barrier to expand potato production [**both seed and ware potato**] in the study area.*

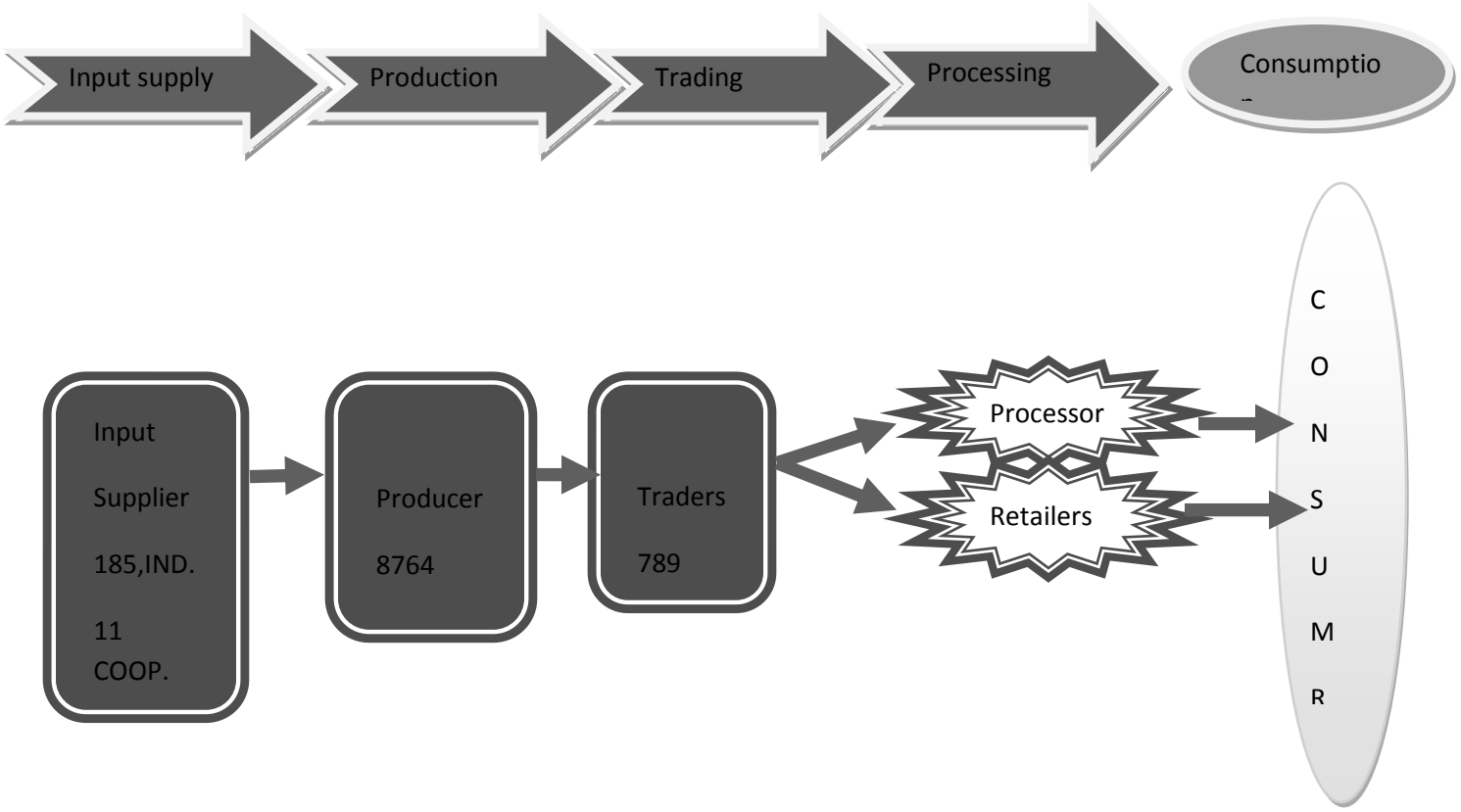
5.8.2 VALUE CHAIN ANALYSIS

One of the key objectives of the present study is to assess and investigate the potato value chain analysis and hence to find out the most pressing bottlenecks first and address them in a systematic manner. So the researcher tries to find out the bottlenecks issue related to functions, actors, linkage among them, or even external factors such as policy and infrastructure. It also examines the value added by each link in the chain.

5.8.2.1 VALUE CHAIN MAP

The value chain map in the study area depicts the flow of potato in the market, activities carried out at each step, the structure of actors and the support involved in the value adding process. Figure 5.9 below shows the potato value chain map in the study area. The figure in parenthesis indicates approximate number of actors under the specific function. The numbers of trader were estimated based on the survey conduct. The number of traders was estimated based on market survey on common market days; it was however, difficult to get data on the number of processors and retailers.

Figure 5.9 Potato value chain in chencha



SOURCE: OWN SURVEY DEC, 2013

5.8.2.2 MARKET ANALYSIS

A) QUANTITY

Chencha is the largest potato marketing center in Gamogofa Zone. Based on the discussion made from wholesaler and retailers, an estimated 2500 ton of potato is marketed in chencha per year. The largest proportion of the product (85 %) is supplied around chencha rural kebele and the rest 15% come from dita district. The potato purchased in Chencha is only partly consumed locally and greater proportion of it is transported to other town specially Arbaminch.

B) POTATO MARKET CHANNELS

Potato passes through various channels until it reaches the final consumers. Some four channel have been identified for ware potato and three channels identified for seed potato. The shorter channel occurs when producers directly sell it to the consumers. The most common type of potato market channels is where the farmers sell it to wholesalers and wholesalers sell to retailers and then retailers sell it to final consumers. But in seed potato commonly farmers or multipliers sell it to NGOs or GOs and then to producers (FIGURE 5.10 AND 11)

FIGURE 5.10 Ware potato Market Channels in Chencha District

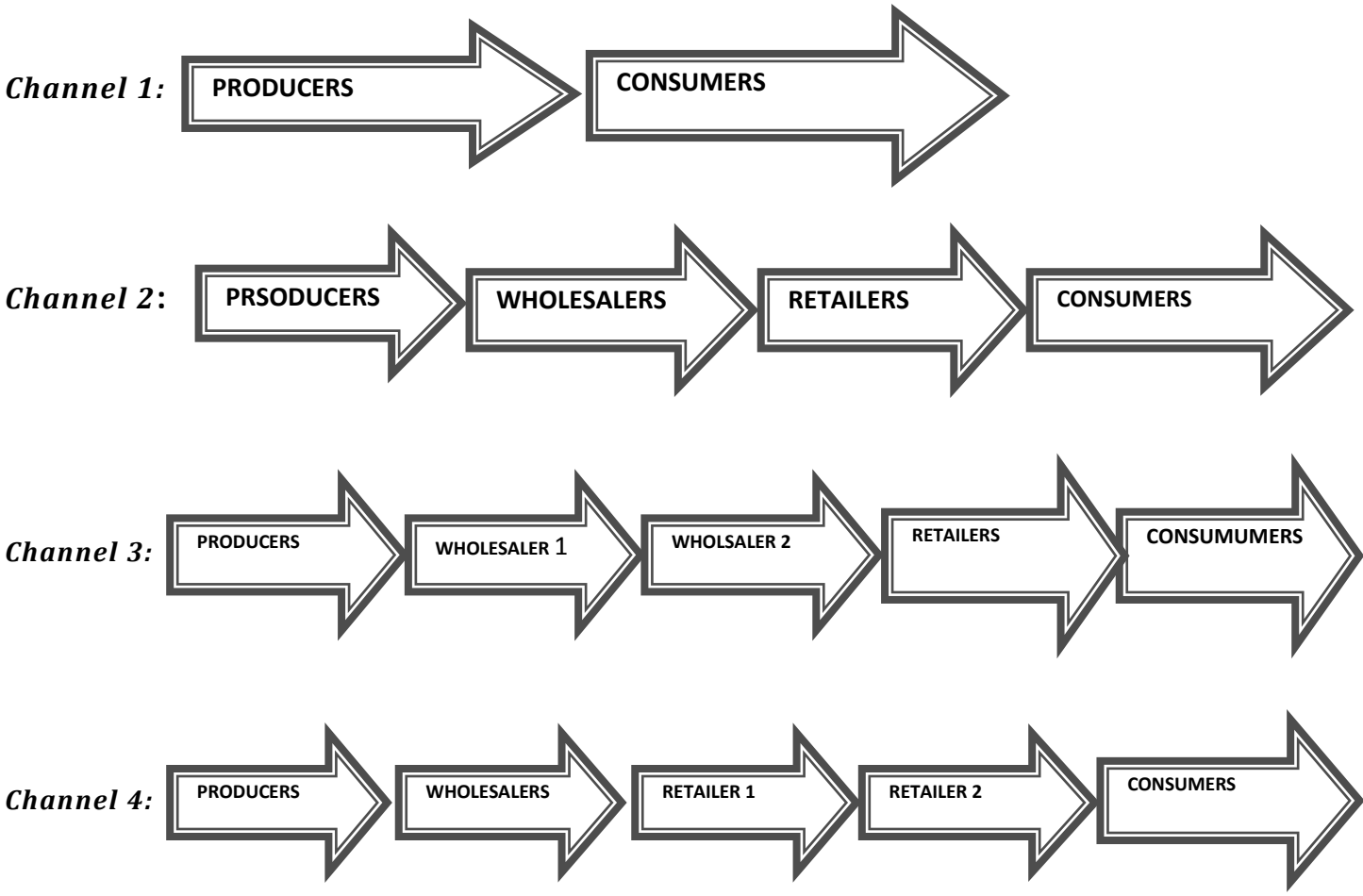
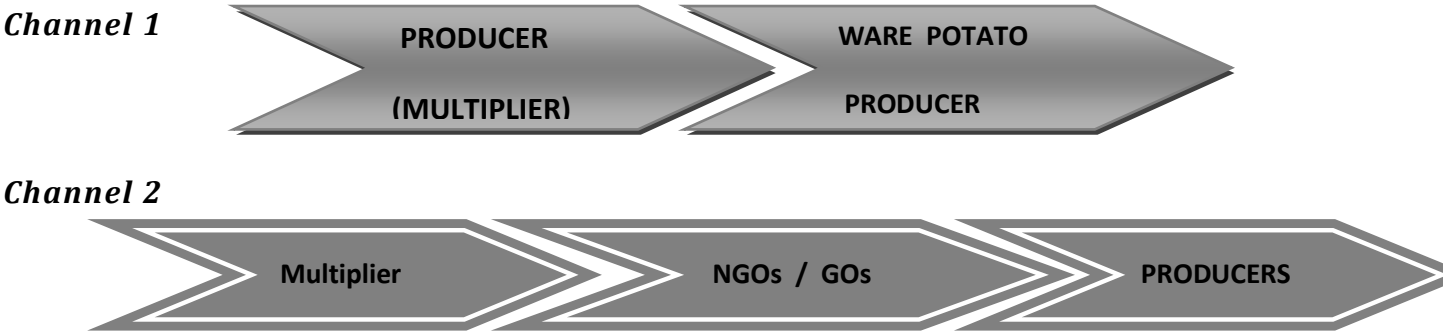


Figure5.11: seed potato marketing channels in chencha



Sources own survey Dec. 2014

5.8.2.3 ECONOMIC ANALYSIS OF POTATO VALUE CHAIN

A) Potato price analysis:

Price of agricultural products have peculiar nature where the prices drastically drop at harvesting time and increase substantially during planting time. The price variability of potato between harvest and planting time is very high due to perishabilty of the product.

B) Cost of potato production:

The average cost of production estimated to produce ware potato per hectare using improved seed and artificial fertilizer is 9,132.00 birr but for seed potato production it is 28,950.00 birr. The cost of seed potato production is higher since it embraces DLS or store construction.

This resulted that the cost of ware potato per ton birr 456.60 but for seed potato it is birr 965.00.

C) Distribution of value addition

Each of the potato value chain actors adds value to the product as the product passes from one actor to another. In a way, the actors change the form of the

product through processing or improve the grade through sorting, cleaning, or washing, or create space and time utility. The distribution of value addition among the potato value chain actors in the study area depict in the following table:

Table 5.21 Distribution of value addition among major chain actors at chencha

Value chain	Producer	Wholesaler	Retailer	Consumer
Sales price (birr / kg)	2.2	3.2	6.25	
Cost of raw Materials	1.10	2.42	3.52	
Gross value added	1.10	0.78	2.73	
% of total value added				

***** total value added = 4.61 per kg***

As table 5.21 shows that the cost of raw materials on producing 1kg of potato product is 1.1birr , the producer sale to wholesalers by including value add done by farmers 2.2 birr per kg and then the wholesaler sale to retailers 3,2birr per kg hence the rate of profit found by wholesaler is 45.45% . the retailers sale 1kg of potato to the consumer 6.25 birr per kg so the rate of profit found by retailer is 95.312%, this shows that high profit or revenue got by traders than producers.

5.8.2.4 FACTORS OF COMPETITIVENESS IN POTATO VALUE CHAIN

The major factors of competitiveness on potato value chain in the study area and their effect in the development of potato value chain based on the reaction of the ***respondent [producer, potato seed multipliers, wholesalers, retailers, brokers and key informants in focus group discussion]*** *were the following:*

Fertility of land and its sizes: soil is a vital resource that must be preserved to support farming sustainability, the *most common soil type at chencha are silty clay loam and clay loam, it is obvious that the best suitable soil for potato is loamy soil. Fertility of soil at chencha are poor and its acidity is very high*

(ph<5) resulted poor quality tuber and abnormal growth . In addition to this because of acidity the soil have problems with common scab. Soil erosion is a crucial problem in this mountainous potato producing area due to sloping fields with steep gradients and high rain fall that affect the fertility of soil. In general low fertility of soil, soil erosion, and soil acidity would lower the yield of potato. Also, the small land size, and dependency on rainfall that in most cases unreliable would considerably reduce the production. So all these critical condition are great threat for potato production and productivity in the study area.

Planting materials:

Seed is the most important factor that affects potato yield. Based on the survey and study results, it has been pinpointed that supply of improved potato varieties was inadequate. Thus, the supply of adequate good quality, late blight resistant and high yield potato seed is determinant for improving potato supply to the market and improves the livelihood of smallholder farmers in the study area.

Know-how:

Farmers know how on improved agronomic practice is improving over time due to the project Better Potato for Better Life. Farmers who participate have better know how than others.

Harvesting technology

In the study area their harvesting system is using by traditional two finger hoe [tsoyele]. The loss is about 20% according to the respondent.

Fertilizer utilization

Farmers who participate in CIP project they applied 165k.g/hectare DAP and 100kg/hectare UREA. But most of other farmers use manure rather than artificial fertilizers.

Quality control

There is no potato quality control mechanism in seed or ware potato regarding to transportation and packing

The other important factors of competitiveness in potato value chain which is not practice in the study area are:

- *Farm advice [specially in potato]*

- *Cleaning*
- *Grading*
- *Branding, Packing, and Safe transport*

5.8.2.5 CORE CONSTRAINTS IN POTATO VALUE CHAIN IN CHENCHA

One of the merits of value chain approaches is that it helps to clearly identify bottlenecks to the development of the chain right from input supply up until the consumption level in vivid way. The constraints identified were in the study area were the following

Table 5.22 core constraints in potato value chain in the study are*a*

VALUE CHAIN	***CORE CONSTRAINTS***
Input supply	**Shortage of improved quality seed* ** Shortage of capital* **low skill* ** low demand*
Production	**low yield* **absence of irrigation facility* **erratic rainfall* **poor diseases and pest control* **poor skill on modern potato farming* **shortage of land* *Shortage of improved seed and high price of inputs*
Marketing	**perishability* **storage facility* **low skill in post harvesting management*
Processing	**lack of processing facility* **low skill* **low technology for processing* *Lack of capital*
Retailing	**Lack of facility* **lack of capital*

Consuming	*Low quality product* *Price fluctuation*

Sources own survey Dec. 2014

5.9 THE ROLE OF WOMENS IN POTATO PRODUCTION AND MARKETING

One of the of the main specific objectives of the study was to investigate the role of women's towards potato production and marketing. So based on the information gotten from respondent the roles were the following:

Table5. 23 women's role

SER. NO	*VARIABLES*	*PERCENTAGES %*
1	*Site selection*	*30 %*
2	*Ploughing*	*10 %*
3	*Spacing and planting*	*50 %*
4	*Weeding and earthening*	*85 %*
5	*Pest and diseases protection*	*10 %*
6	*Harvesting*	*50 %*
7	*Transporting*	*80 %*
8	*Post harvesting technologies*	*90 %*
9	*Marketing*	*33 %*
AVERAGE		*48.7 %*

Source own survey Dec, 2013

Based on the above table the role of women's *towards potato production and marketing was 48.7 which is immense so any training and provision of potato technology should provided to women's equal to men's.*

5.10 MAJOR PROBLEMS ON POTATO PRODUCTION AND MARKETING SYSTEM IN THE STUDY AREA

The main objective of the present study is to investigate and analyze the major problems that hinder the development of seed and ware potato production and marketing. So in order to get the real constraints information and data were collected from selected respondent [100], traders [20], brokers [10], retailers [20], and their reaction were the following: The major potato production problems that are identified in the study area are the following existing low productivity of potato in chencha.

Some of these include shortages of good quality seed tubers of improved cultivars; disease and pests; and lack of appropriate agronomic practices, including optimum plant density, planting date, soil moisture, row planting, depth of planting, ridging, and soil fertility status .The optimizing of plant density is one of the most important subjects of potato production management, because it affects seed cost, plant development, yield, and quality of the crop . The yield of seed potato can be maximized at higher plant population (closer spacing), by regulating the number of stems per unit area, or, to a certain extent, by removing the haulm earlier during planting. Intra-row spacing was significant on yield of potatoes: the 20-cm intra-row spacing, in comparison with 30-cm spacing, showed 13.9, 59.8, and 30.39% increase in yield. Intra-row distance of 20 cm increases total tuber number and weight, and tuber weight per plant and the marginal return rate increased by 13% when intra-row distance decreased from 35 to 25 cm. Little difference in yield between intra-row spacing of 25 and 30 cm for JALLENEA, and the 30-cm intra-row and 75-cm inter-row spacing are accepted as standard. Owing to the lack of region-specific recommendations for inter- and intra-row spacing, farmers in the study area (CHENCHA) use different spacing (below or above) than that of the national recommendation, depending on the purpose of planting either for ware or seed tuber. Hence, it is important to maintain appropriate plant population per unit area to have high yield, marketable size, and good qualitseed tuber. Even though different research on potato plant density is done in different parts of the country, the condition in CHENCHA was not the as others. Generally in checha, significantly, maximum total number of tuber (532,865) per hectare was recorded at 65 cm inter-row

spacing [Ato Tesfaye farm]. The lowest number of tuber (447,586) per hectare was obtained at wider spacing (80 cm) of inter-row spacing. Effect of intra-row spacing was significant. Maximum total number of tubers (558,174) per hectare was obtained from 20-cm spacing, whereas the lowest total number of tubers (430,311) per hectare was recorded at 35-cm spacing. Total tuber number per hectare, however, increased with closer spacing due to high number of plants per unit area. THE result show as that intra-row distance of 20 cm increased total tuber number and weight per unit area. ***Based on the information the problems were categorizing in three parts economical, natural and technical and prioritize as follows:***

Natural limitations:[problems]

- *Drought and erratic RF*
- *High Temperature and Frost*
- *High disease and insect pressure*
- *Flooding.*

Table 5.24 pair wise ranking on potato natural limitation

Drought & Erratic rain fall	***High Temperature and Frost***	***High disease and insect pressure***	***Flooding***		***Score***	***Rank***
-	*Drought & Erratic rain fall*	*Drought & Erratic rain fall*	*Drought & Erratic rain fall*	*Drought & Erratic rain fall*	*3*	*1*
	-	*High disease and insect pressure*	*Flooding*	*High Temperature and Frost*	*0*	*3*
		-	*High disease and insect pressure*	*High disease and insect pressure*	*2*	*2*

			-	*Flooding*	*0*	*3*

Source: own field survey 2013

- *Based on the above table regarding to natural limitation that hinder the development of potato production and marketing which prioritise by the respondent were* Drought and erratic RF, High disease and insect pressure, High Temperature and Frost and Flooding.

Economic (market) problems

- *High transaction and handling costs*
- *Low and fluctuating prices*
- *Absence of organized marketing systems*
- *Low demand*
- *High seed potato price*
- *Broker interference*
- *Trader gives the same price to the producer*
- *No market*
- *Poor road access and transport*
- *Perish ability*
- *Lack of storage facility*
- *Low skill In post harvest technology*

- *Lack of capital*
- *Low skill in processing technology*

After identified the economic (market) problems the respondent also prioritized them using pair wise ranking which the result are the following:

Table 5.25 pair wise ranking on potato economic problems

											SCORE	RANK
Perish ability	Poor road access and transport	No market	Trader gives the same price to the producer	Broker interf-erence	High seed potato price	Low demand	Absence of organized marketing systems	Low and fluctuating prices	High transaction and handling costs			
-	Perish ability	Perish ability	Perish ability	Perish ability	High seed potato price	Low demand	Perish ability	Low and fluctuating prices	Perish ability	Perish ability	6	2
	-	Poor road access and transport	Trader gives the same price to the producer	Poor road access and transport	High seed potato price	Low demand	Poor road access and transport	Low and fluctuating prices	Poor road access and transport	Poor road access and transport	5	3
		-	Trader gives the same price to the producer	Low and fluctuating prices	High seed potato price	Low demand	Absence of organized marketing systems	Low and fluctuating prices	High transaction and handling costs	No market	1	6
			-	Trader gives the same price to the producer	High seed potato price	Low demand	Absence of organized marketing systems	Low and fluctuating prices	Trader gives the same price to the producer	Trader gives the same price to the producer	3	4
				-	High seed potato price	Low demand	Absence of organized marketing systems	Low and fluctuating prices	High transaction and handling costs	Broker interf-erence	1	6
					-	Low demand	High seed potato price	Low and fluctuating prices	High seed potato price	High seed potato price	5	3
						-	Low demand	Low demand	Low demand	Low demand	5	3
							-	Absence of organizd marketing systems	Absence of organizd marketing systems	Absence of organizd marketing systems	6	2

								-	***Low and fluctuating prices***	***Low and fluctuation prices***	**7**	**1**
									-	***High transaction and handling costs***	**2**	**5**

Source: own field survey 2013

As table above depict that the respondent prioritise the economic problems that hinder potato development and marketing were Low and fluctuating prices , Absence of organized marketing systems and perishability , ow demand, high seed potato price and poor road access and transport ,trader gives the same price to the producer, high transaction, broker interference , no access to market place (table-).

Technical problems: identified by the respondent

- *Lack of sufficient quantity of good quality seed tubers*
- *Lack of appropriate cultivars*
- *Sub-optimal agronomic techniques specially spacing*
- *Lack of storage facilities for both ware and seed tubers*
- *Shortage of skilled manpower and facilities*
- *Limited knowledge on nutritional value developed cultivars*
- *Lack of processing industries*
- *Very low production and productivity*
- *Quality certified of seed potato*
- *Poor integration with main stakeholders [research, cooperatives, NGOS, GOS, community empowerment, private initiatives]*

The above technical problems were prioritize by the respondent using pair wise ranking [PRA techniques], the result were the following:

Table 5.26 pair wise ranking on potato Technical problems

Lack of sufficient quantity of good quality seed tubers	*Sub-optimal agronomic techniques*	*Lack of storage facilities for both ware and seed tubers*	*Shortage of skilled manpower and facilities*	*Limited knowledge on nutritional value developed cultivars*	*Lack of processing industrie*	*Very low production and productivity*	*Quality certified of seed pot[ato QUALITY SEED PLANTING MATERIAL CERTIFICATION]*	*Poor integration with main stakeholders [research, cooperatives, NGOS, GOS, community empowerment, private initiatives]*		score	ranking
	Lack of sufficient quantity of good quality seed tubers	*Lack of sufficient quantity of good quality seed tubers*	*Lack of sufficient quantity of good quality seed tubes*	*Lack of sufficient quantity of good quality seed tubers*	*Lack of sufficient quantity of good quality seed tubes*	*Lack of sufficient quantity of good quality seed tubers*	*Lack of sufficient quantity of good quality seed tubers*	*Lack of sufficient quantity of good quality seed tubers*	*Lack of sufficient quantity of good quality seed tubers*	9	1
		Lack of storage facilities for both ware and seed tubers	Shortage of skilled manpower and facilities	*Sub-optimal agronomic techniques*	*Sub-optimal agronomic techniques*	*Very low production and productivity*	*Sub-optimal agronomic techniques*	*Poor integration with main stakeholders [research, cooperatives, NGOS, GOS, community empowerment, private initiatives]*	*Sub-optimal agronomic techniques*	3	5
			Lack of storage facilities for both ware and seed tubers	Lack of storage facilities for both ware and seed tubers	Lack of storage facilities for both ware and seed tubers	*Very low production and productivity*	Lack of storage facilities for both ware and seed tubers	Lack of storage facilities for both ware and seed tubers	*Lack of storage facilities for both ware and seed tubers*	6	3
				Shortage of skilled manpower and facilities	Shortage of skilled manpower and facilities	*Very low production and productivity*	Shortage of skilled manpower and facilities	*Poor integration with main stakeholders [research, cooperatives, NGOS, GOS, community*	*Shortage of skilled manpower and facilities*	4	4

								empowerment, private initiatives]			
					Limited knowledge on nutritional value developed cultivars	Very low production and productivity	Quality certified of seed pot[ato QUALITY SEED PLANTING MATERIAL CERTIFICATION]	Poor integration with main stakeholders [research, cooperatives, NGOS, GOS, community empowerment, private initiatives]	Limited knowledge on nutritional value developed cultivars	1	6
						Very low production and productivity	Quality certified of seed pot[ato [QUALITY PLANTING MATERIAL CERTIFICATION]	Poor integration with main stakeholders [research, cooperatives, NGOS, GOS, community empowerment, private initiatives]	Lack of processing industrie	0	7
							Very low production and productivity	Very low production and productivity	Very low production and productivity	8	2
								Quality certified of seed potato	Quality certified of seed potato	3	5
									Poor integration with main stakeholders [research, cooperatives, NGOS, GOS, community empowerment, private initiatives]	4	4

Source: **own field survey 2013**

As table 5.26 above illustrated the technical problems that hinder development of potato production and marketing system were lack of sufficient quantity of good quality seed tubers, very low production and productivity, lack of storage facilities for both ware and seed tubers, poor integration with main stakeholders [research, cooperatives, NGOs, Gos community empowerment, private initiatives] and shortage of skilled manpower and facilities, sub-optimal agronomic

techniques and quality certified of seed potato [quality planting material certification], limited knowledge on nutritional value developed cultivars, and lack of processing industries. altogether, these are big issues that deserve attention, if the full potentials of this important crop, as well as its contributions to sustainability of agriculture in the study area, are ever to be realized. it is very high time to conduct research, to develop economically, socially and technically sound potato supply system in chencha for people indeed!!

5.11.1 CASUAL CHAIN ANALYSIS ON MAJOR PROBLEMS OF POTATO PRODUCTION AND MARKETING SYSTEM

Here under this title it explains and investigates the root cause and effect of the major problems that identified in the previous chapter, which helps to recommend the best possible and practical solutions of the problem that hinder the development of potato production, and marketing system.

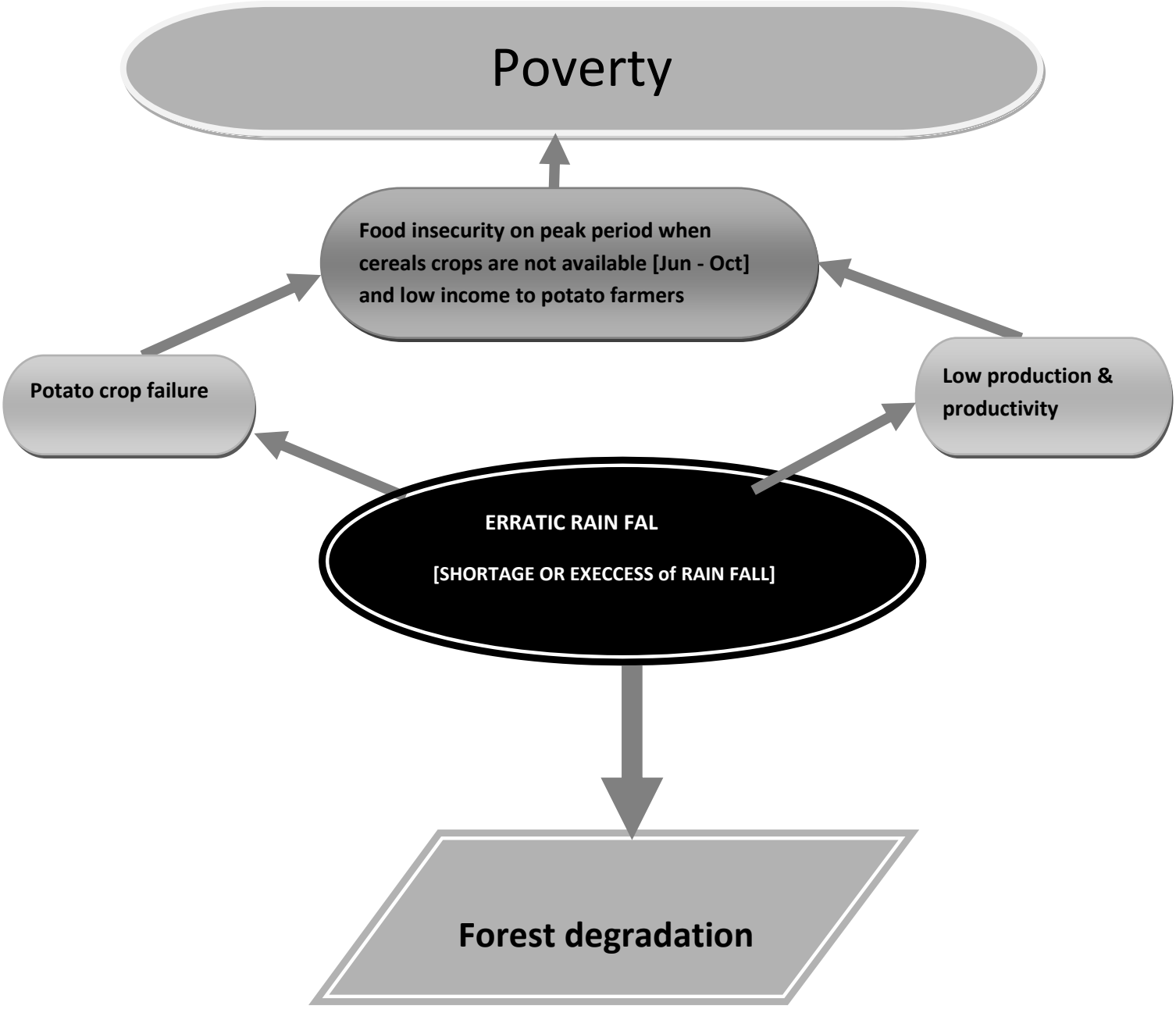


FIGURE 5.12 Natural limitation [problem] analysis

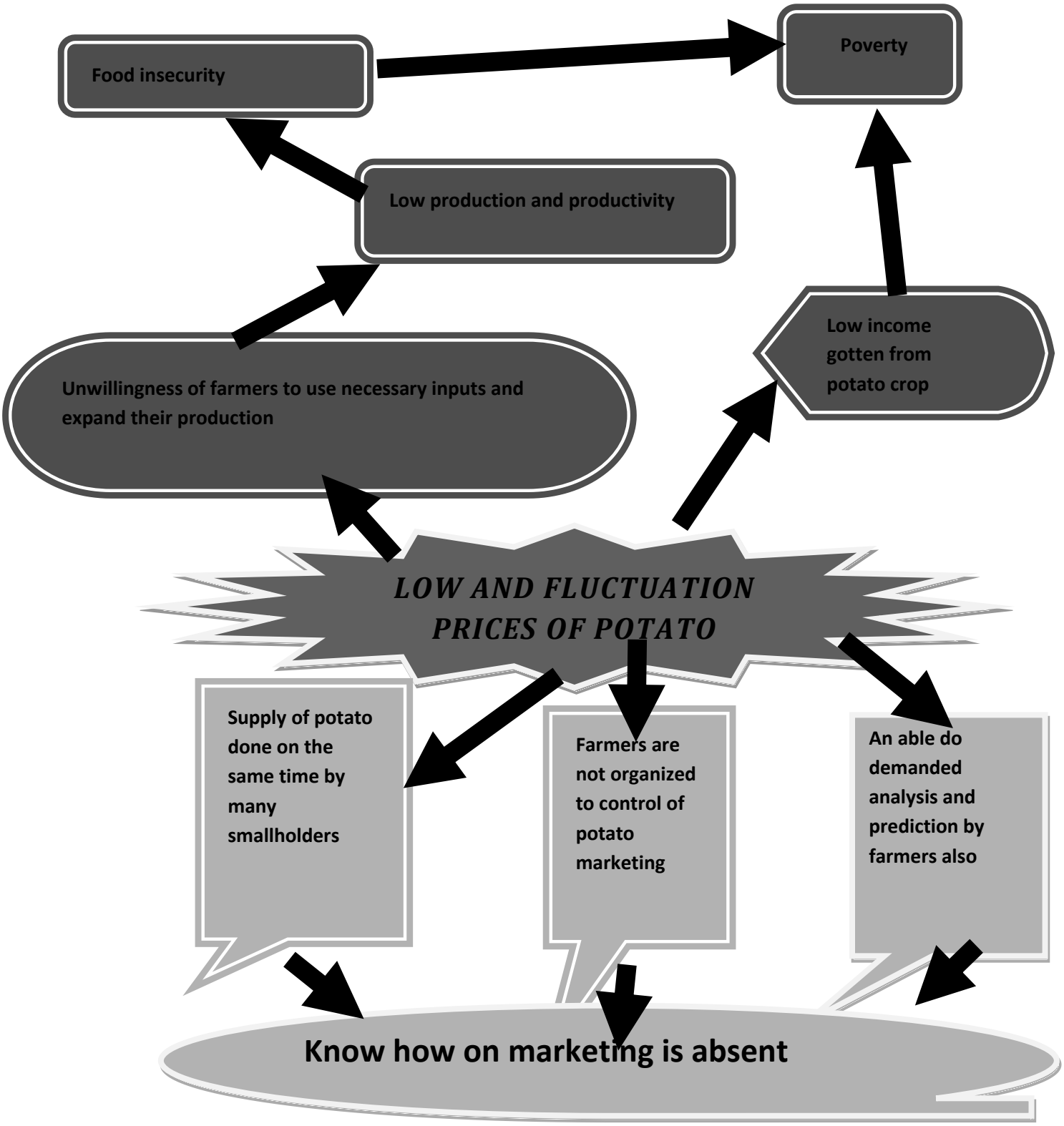


Figure 5.13 economic [marketing] problem analysis

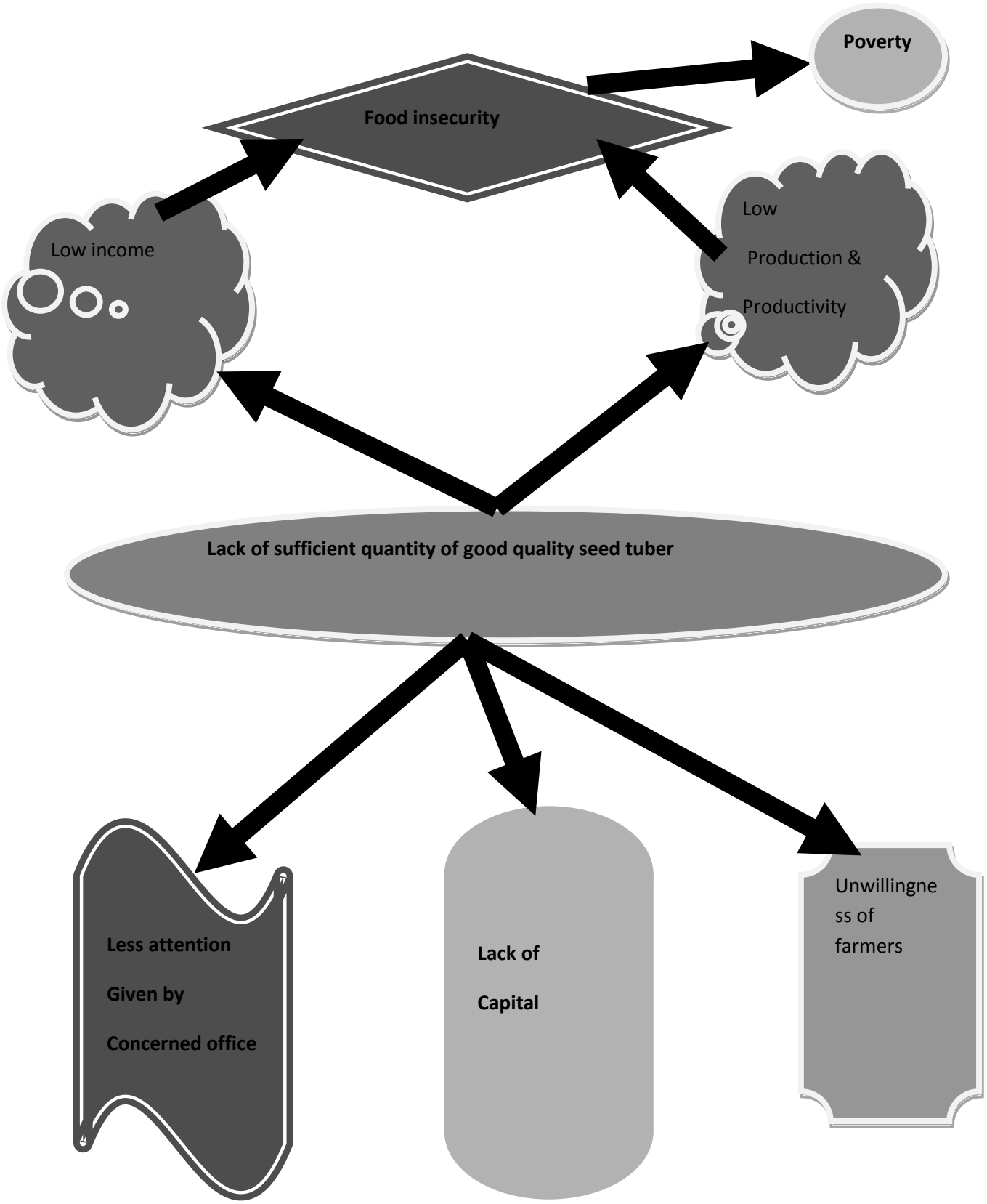


Figure 5.14 casual chain analysis on major technical Lack of sufficient quantity of good quality seed tuber

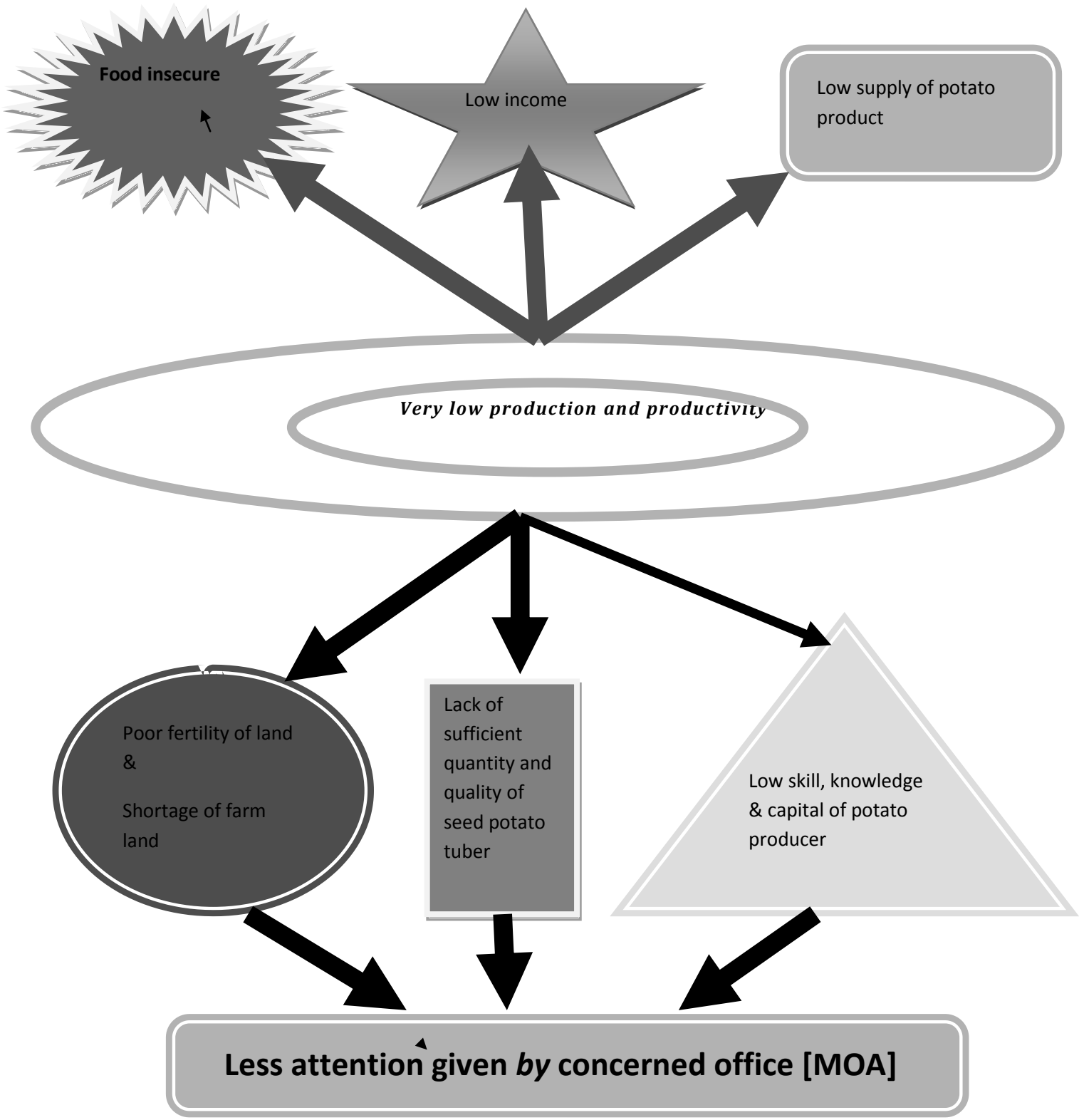


Figure 5.15 casual chain analysis on major technical problems on very low production and productivity

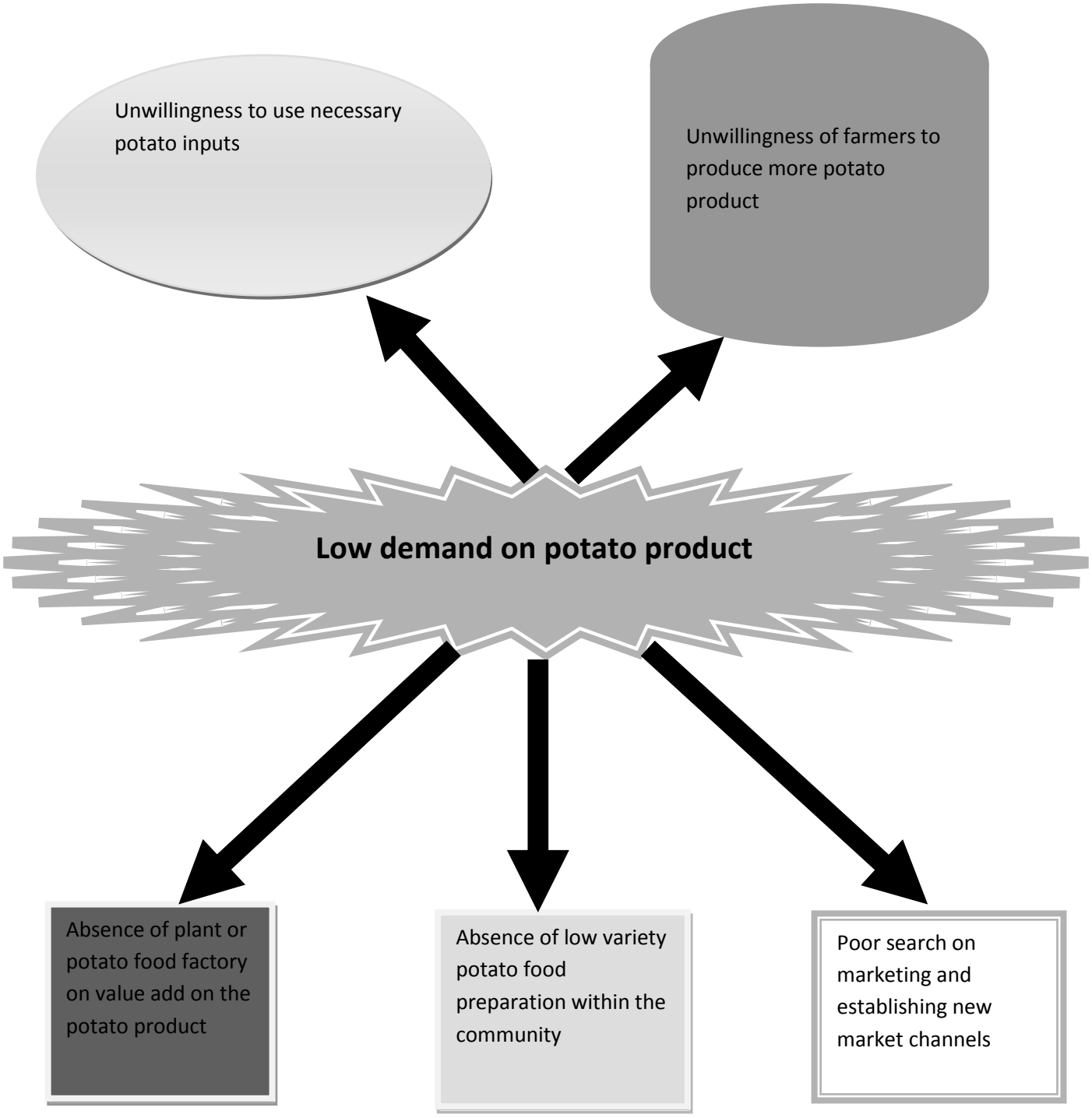


Figure 5.16 economic [marketing] problem analysis on low demand

Figure 5.12 casual chain analysis on major technical problems on lack of storage facility for both ware and seed tuber

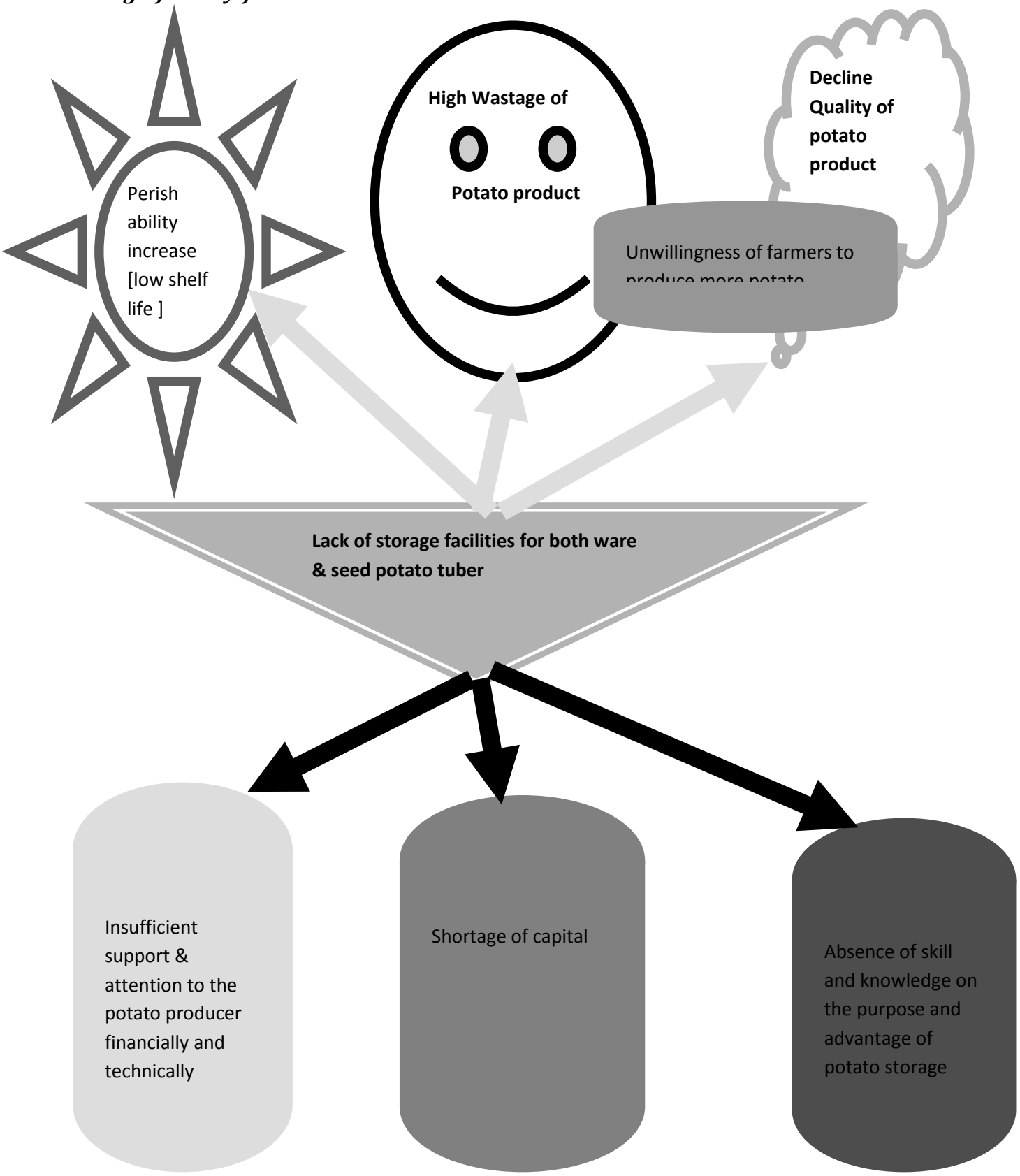


Figure 5.17 casual chain analysis on major technical problems of Poor integration with main stakeholders [research, cooperatives, NGOS, GOS, community empowerment, private initiatives and value chain actors]

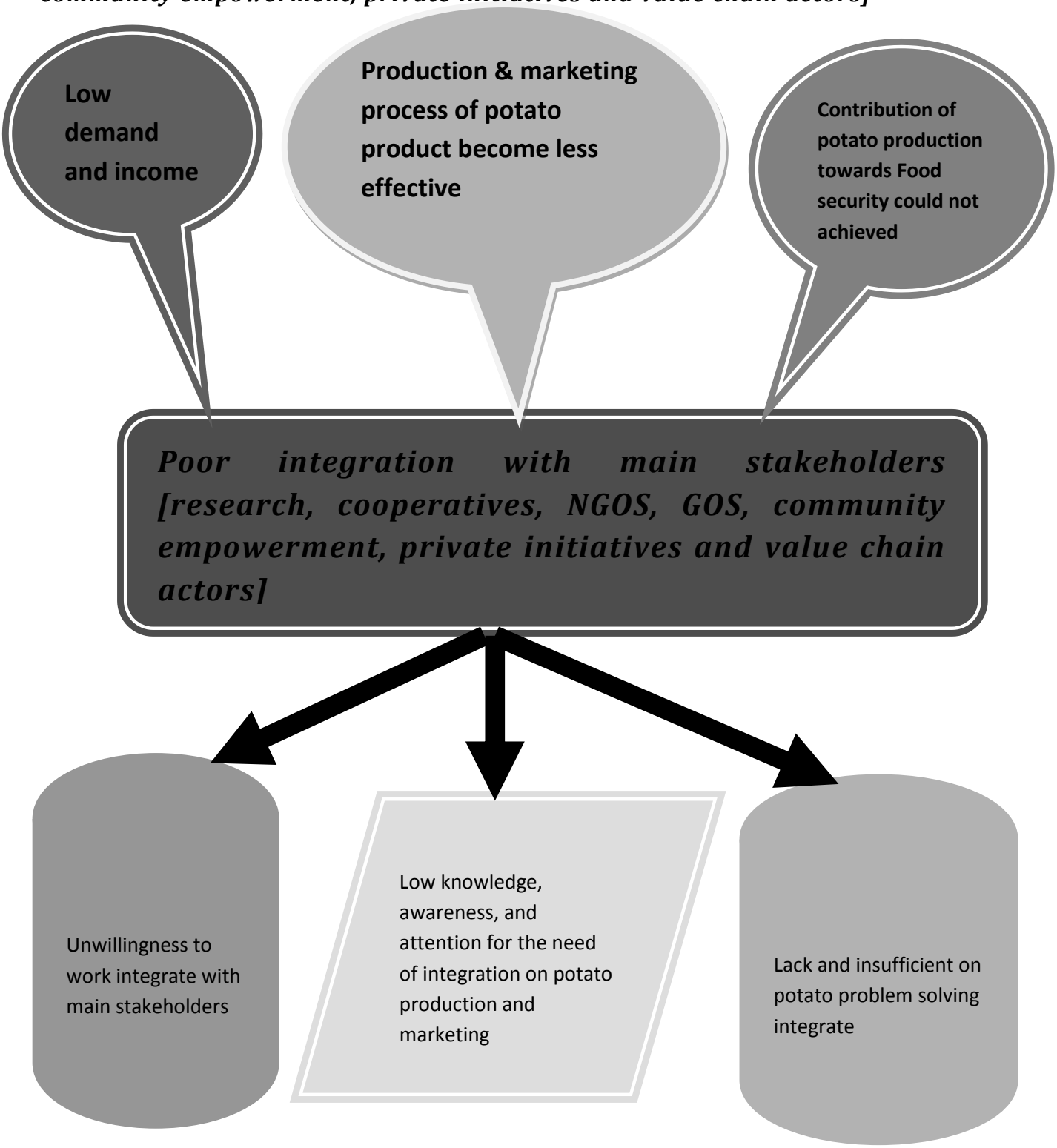
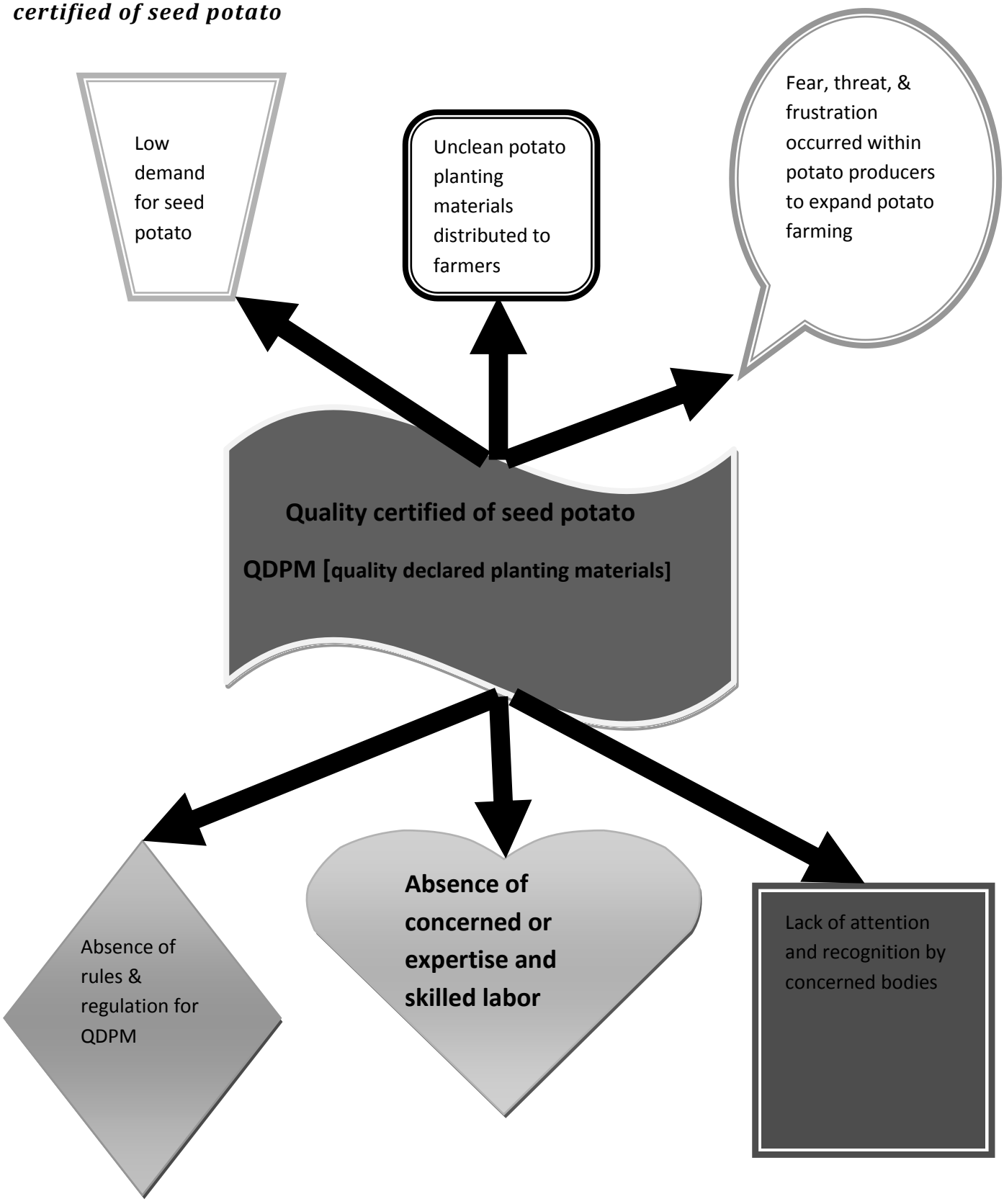


Figure 5.18 casual chain analysis on major technical problems of Quality certified of seed potato



CHAPTER SIX

6. CONCLUSION AND RECOMMENDATION

6.1 Conclusions

The study was undertaken to explore the problems and prospect of potato production and marketing by taking chencha district, gendogamebella and dokoyoyera rural kebeles as a case study. It entails the specific objectives of investigating the major problems that hinder the development of potato production, To examine the trend of production, consumption and productivity of potato, To evaluate the performance of smallholder farmers potato farming practice based on modern techniques [Assessing and examining of potato technological innovation], To explore the contribution of potato production towards food security , income of the smallholder farmers ,and To assess potato value chain analysis and development. Primary data was collected from 100 smallholder farmers [potato growers], 10 traders, 20 retailers, 5 brokers and 2 focus group. These was supplemented by information from MOA , NGOs and key informant. Based on the result found in the study the following points are concluded:

- *As the result of the study exuberates the total seed potato production found from 50 respondent of seed potato multipliers in the year of 2011 belge season were 4492 quintals from 13 hectares of land , which gives productivity on this season 345.5 quintal per hectare. But during the same year in mhear season it was found 1047 quintal from 3.5 hectares and the productivity were 299.14 , compare to belge season the production and productivity on belge season found better yield . According to the respondent reaction the reasons for better yield and productivity were found in belge season it is because of suitable temperature during this period. During the year 2012, the productions found in belge were 4848 from 16.25hec. and its productivity was 298.34, in mehear season of the same year production was found 1225qn. from 3.5he and its productivity was 350 q/ hec. In the year of 2013 belge season seed potato production found 4118qn.from 16.25hec. and its productivity were 253.42 qn.*

/hec, But in mehear season on the same year it was found 2302 qn of seed potato production from 10.75 hectares of land which gives the productivities to 214.14 quintals per hectares. The total production of quality, high yield and LB resistant seed potato that produced by the respondent from the year 2011-2013 [in 3 years] were 18032qn by cultivating 64.70 hectare which gives the average productivity of seed potato were 278.7quintals.

- *The productivity of seed potato based on physical yield assessment d were 278.5quintal per hectare of which 30 sample taken from 10 respondent of seed multiplier. But the average productivity found based on the information given from 50 respondents were 299.1quintal per hectare in belge season and 252.76quintal per hectare in meher season. So in the study area the productivity of improved late blight resistant and high yield seed potato were relatively the same from both sources that are 278.5quintal per hectare. The total production of seed potato in the three consecutive years were 5539 quintal in the year of 2011, 6073qn in the year of 2012, and 6420qn in 2013. The growth rate of seed potato production 9.6 % in 2012 and 5.7 % in 2013 this shows that the growth rate is minimum. GENERALLY one can conclude that as explain in the above two tables maximum yield of seed potato per hectare were found 355qn and the minimum were 175qn / hectare.*
- *Shortage of quality seed tubers of improved cultivars is one important limiting factor to potato productivity and production. The last three years experiences indicated that there is a good prospect for producing better quality seed potato on farmers'field in collaboration with other stakeholders. Currently, few formal private initiatives are engaged in potato seed production as a business. However, informal seed multiplication programs conducted by different NGOs and agricultural office and other partner organizations were effective in disseminating improved potato varieties to farmers covering about 9.6 %.*

- *Based on the respondent reaction the total ware potato production produced from the year 2011- 2o13 from 50 ware potato producer and respondent were 3407 quintals of potato by cultivating 41.87 hectares of land which gives the productivity of ware potato per Hectare 81.4 quintals. The average potato farm size based on the respondent was 0.1394 Hectare which is equivalent to one seventh hec.*

- *As sample taken during the study shows that, the maximum yield found was 330 qn/hec and the minimum were 40 qn/hec. The highest [200-33oqn] was found almost from ten farmers it is due to that they used new and improved varieties the so called jallene, fertilizer, and some better agronomy practices, the rest of them were not willing to take this varieties and adopt the new techniques due to their interest and other reasons. The productivity of seed and ware potato has got big difference that is an average 197qn. The productivity of ware potato were 74.64 quintal per hectare based on physical yield assessment in terms of 30 sample taken from 10 respondent of ware potato producer . But the average productivity found based on the information given from 50 respondents was 81.4 quintal per hectare. So in the study area the productivity of ware potato from both sources show that there is some difference which was [81.4-74.64] 9.46 quintal per hectare. Based on sample taken in the field from 10 farmers [respondent] shows as the productivity of ware potato in the study area was 74.64 quintal per hectare.*

- *The total demand of high quality, late blight resistant, high yield and improved variety of seed potato in the year of 2014 is 26020.4 quintals and the total demand for ware potato in the year of 2014 is estimated – total population 140590 x consumption per head 2.5 quintals = 351,475 quintals. The study result that the supply of high quality, late blight resistant varieties seed potato in the year 2014 are 24418.88 quintals. Based on this analysis it is advisable that the number of high quality seed potato multipliers and area cultivated should not exceed 320 HH and 80 hectares.*

- *The annual supply of ware potato in the study area in the year of 2014 will be 303048 quintals. Based on the above demand and supply for potato product study result the analyses were summarized below:*

SUMMARY TABLE 27 ON DEMAND & SUPPLY ANALYSIS OF POTATO IN 2014

ITEMS	***DEMAND***	***SUPPLY***	***GAP***
SEED POTATO	***26020.4 QUINTALS***	***24418.88 QUINTALS***	***Qd>Qs by 1601.52 qn***
WARE POTATO	**351,475 QUINTALS**	**303048 QUINTALS**	***Qd>Qs by 49427 qn***

- *The feasibility and cost benefit study analysis of seed and ware potato production [profitability] in the study area using payback period, NPV, IRR, and CBR showed and indicates that producing of seed and ware potato by farmers were profitable farming practice ever had in any other agricultural practice so potato is a buried treasure for smallholder farmers these is because that profit earned per hectare in seed potato production was birr**96,450** and in ware potato birr **65,000**, NPV were **Birr 609,147.45** , CBR , 5.67 IRR 56.7% and the payback period were less than one year.*

- *The study result showed that the Potato is an important crop for smallholder farmers in chencha, serving as both a cash and food security crop. It is one of the root crops widely grown in the study area with the highest rate of growth because increasing demand and emerging markets are providing great opportunity for resource-poor farmers to generate additional income specially.*

- *The result of this study regarding to potato value chain analysis depict that the main actors are input suppliers , potato producers, traders, retailers, processors, and consumers.*

- *Potato market channels where Potato Passes through various channels until it reaches the final consumers, some four channel have been identified*

for ware potato and three cannels identified for seed potato. The cost of ware potato production per ton birr 456.60 but for seed potato it is birr 965.00. The major factors of competitiveness on potato value chain in the study area were fertility and size of land, knowhow, quality of seed potato, harvested technology, fertilizer utilization, quality control, farm adviser, grading and safe transport. Generally the result of potato value chain analysis in the study area clearly stated the lowest benefit was found by producer compare to other actors in the value chain.

- *According to the study the major and bottle necked problems and core constraints that hinder the development of potato production, marketing and value chain were erratic rainfall, unfavourable climates, High transaction and handling costs, Low and fluctuating prices, Absence of organized marketing systems, Low demand, lack of sufficient quality and improved potato seed with High seed potato price, Trader gives the same price to the producer, Poor road access and transport, Perish ability, Lack of storage facility Low skill and knowhow on improved potato technology, Lack of capital, Very low production and productivity and poor access to market*
- *The average adoption rate and dissemination of improved potato technology to seed potato producer was 85.85% and to ware potato producer were 32% which shows low rate. Expansion, dissemination and implementing improved potato technologies as it required in sustainably in the study area is under question because of the above problems and constraints.*
- *With proper technical advice and backstopping, farmers are able to produce high-quality seed through their own management;*
- *Use of quality seed leads to increased tuber yields at farm level (average of 32.12 t/ha);*
- *Working in partnership is important for technology dissemination;*
- *Farmers are keen on improved technologies (other agricultural technologies);*

• Farmers are not interested in —Select the Best, which takes more time, and

Prefer improved seed; and

• Organizing farmers into FRGs or cooperatives helps to reach more farmer sin technology dissemination.

6.2 RECOMMENDATIONS

Based on the study result and problem encountered in potato production and marketing system in the study area the following suggestion and recommendation are recommended:

Input supply:

1)Establish and or strengthen cooperative , group, individual, FTC that engage potato seed production to achieve the economies of scale needed to meet ware potato producer high demand for improved potato seed.

2) in the study area farmers continue to use improved potato Variety [jallene, gudennae] Distributed 3 years ago, obviously , the productivity of the seed decline overtime. Thus Improved potato seed replacement system should be put in place by involving the relevant stakeholders (MOA, NGOs, and Research institution and seed producers). The system should enable farmers to replace the improved Variety at regular interval.

3) Increasing the traditional seed system by introducing improved seed production and Marketing system widely.

4) Applying quality assurance techniques as the required time (from sit selection to post harvest handling practices)

STORAGE FACILITY:

Potato is highly perishable agricultural product so it needs proper storage. In the study area lack of storage facility for seed and ware potato was raised by farmers and other actors as a priority problem so:

1) *It is recommended to Expand DLS as per standard DLS design and construction.*

2) *Through technical support to the farmers cost effective mechanism of expanding DLS should be considered*

3) *Build communal DLS and ware house through integration*

4) *Build capacity of Government staff specially Development agents to control the quality of DLS constructed at house holed level*

5) *Apply cost sharing method on the construction of DLS and ware house at household level*

6) *Create Access to loan to potato producer for the construction of DLS and ware house*

PRODUCTION:

1) *Potato specific technical recommendations should be adequately disseminated (sit selection, ploughing, spacing, weeding, fertilisers, post harvest technologies) to increase potato production and productivity.*

2) *Impute provision should be adequately scheduled to meet the cropping calendar of potato*

3) *Awareness creating and raising program on potato food value and its processing techniques is recommended and can promote potato consumption.*

4) *Crop protection on cost sharing sprayer supply mechanism should be put in place*

TRANSPORTATION:

1) *It is important to establish potato transportation standards and enforce it*

2) *Constructing and maintaining feeder roads up to potato farm through integration*

3) *Properly packing seed or ware potato product using wood or other necessary materials to combat Damage of potato product during transportation*

4) *Establish and strengthen potato producer cooperative union at woreda level to buy track*

MARKETING:

1) *Standardization of weighing scale in participatory manner.*

2) *Broker should operate legally*

3) *Organize and capacitate potato producer to enhance their negotiation power*

PROCESSING:

1) *Introducing potato producing facilities*

2) *Facilitate the engagement of private food processing plants in processing potato*

- *increasing smallholder potato farmers'income by boosting potato yields*

  Through improved seed potato quality management and crop husbandry;

- *improving market linkages and communication between potato value chain stakeholders.*

- *Further exploit the newly introduced varieties of Belete, Zengena, and Guasa.*

- *Cooperatives should be able to stand on their own feet and actively assess*

  Market opportunities by themselves;

Focuses of Future Research

- *Characterization of potato production areas and systems;*

- *Introduction and screening of potato genotypes for different purposes, agro ecologies, and production systems;*

- *Strengthening the generation of local populations to develop potato varieties;*

- *Identification of low-input and nutrient-efficient potato cultivars;*

A QUESTIONNAIRE TO COLLECT DATA ON PROBLEMS And PROSPECT OF POTATO PRODUCTION AND MARKETING ACTIVITIES IN SOUTHERN REGION, GAMOGOFA ZONE, CHENCHA DISTRICT, ETHIOPIA

NOTE: This questionnaire has been prepared for academic research purpose. the information you are going to provide will not passed over to government officials, tax collector or any other third party. Therefore, you are kindly requested to give genuine responses as the success of research depends on how genuine your answer are. Thank you very much.

1- GENERAL QUESTION

1.1 Respondent Characteristics

- Household head name----------Sex ----------Age--------level of education -------
- Years of experience in potato production and marketing purpose----------
- Number of family Male---------- Female----------Age----------

2- RESOURCE ENDOWMENT

2.1 Total farm size ----------ha. covered by potato----------ha

2.2 Livestock (Yearly Average Inventory)

ox-----bull-----heifer---calf-------sheep----------goat----------horse--------mule----------

donkey-----poultry----------beehives---------

2.3 Perennial Trees (Yearly Average Inventor)

Apple----------

2.4 Farm Implements Owned by the household

----------,----------,----------,----------,----------

3- POTATO PRODUCTION AND INPUT USE IN 2012/13 BELGE/MEHER SEASON

DESCRIPTION	UNIT	2o11		2012		2013	
		Belge	Meher	Belge	Meher	Belge	Meher
Total area cultivated by potato	Ha						
Labor used	p/d						
Fertilizer used UREA DAP	Quintal						
Chemical used							
Yield found	Quintal						
Total cost of production	birr						
Total consumed	Quintal						

Total marketed or sold	**Quintal**						
Total cash found by household from sailing potato	**Birr**						

5) What is the typology of current technology in use in the production process ?

---
a.) Varieties used by the producer's _____, _____, _____

b) How effectiveness is the technologies? Modern one??----------
---
---
6) What indigenous and other knowledge is being used in the production process ?----------
---

---
7) Does the Knowledge & Technology produce the required output?
a) Modern one ?----------
---
b) indigenous one ?----------
---

8) What does the use of technology cost? What about the benefit?----------
---
---
9. What are the major problems in potato production, post harvest, marketing and Transportation in your area?

a) Production related problems ----------, ----------
---, ----------, ----------
---,----------,----------
---
b). Post harvest related problems: ----------,----------
---,----------
----------,----------,----------
c). Market related problems:----------

---
d). Transport related problems:
_____

28. Please indicate potato activity calendar in your locality?

A) DURING BELGE SEASON

NO	ACTIVITIES	J	F	M	A	M	J	J	AU	SEP	OCT	NOV	DEC
1	Land Preparation												
2	Planting												
3	Fertilizing												
4	Weeding												
5	Pest & diseases control												
6	Harvesting												
7	Marketing												
9	Low price time												
10	Medium price time												
11	High price time												

B) DURING MEHER SEASON

NO	ACTIVITIES	J	F	M	A	M	J	J	AU	SEP	OCT	NOV	DEC
1	Land Preparation												
2	Planting												
3	Fertilizing												
4	Weeding												
5	Pest & diseases control												
6	Harvesting												
7	Marketing												
9	Low price time												
10	Medium price time												
11	High price time												

9-POTATO MARKETING RELATED QUESTIONS

- Personally by looking for the potential buyers (----------)
- With the help of middlemen by paying commission (----------)

- Through cooperatives (_____)

10. Do you grow potato as **sole crop or intercrop** with other crops?
a) Sole crop b) Intercrop with others

11. Where do you **get potato seed**?
a) Use own b) market c) MOA d) cooperatives e) other specify—

12. What type of potato variety are you currently using?
a) local b) improved?

13. If improved potato, indicate year you first used improved seed? ____ years?

14. Do you get enough yield from potato variety you currently grow?
1) Yes 2) No

15. If No, what are the major reasons for low results? (indicate all reasons)
1) poor quality seed 2) disease 3) no enough land 4) others
specify_____

16. Where do you **store potato after harvest**?
1) in sacks 2) spread on the floor inside house
3) keep in the soil and dig out when needed 4) others specify_____

17. Estimate **potato loss after harvest** (before sale). _____% of harvest.

18. How long do you store (usually) potato (between harvesting and selling)? _____ Days

14. How do you transport potato to market? 1)on donkey back 2) by truck 3) on human Back 4) other specify?

15. To **whom do you sell ware potato**?

16. Where do you sell ware potato?

17. To whom do you sell seed potato?

18. Where do you sell seed potato?

19. Who are involved in the sales of potato? Brokers, commission agents, traders, Transporters, etc.

Appendix 1. seed potato production assessment

On 50 respondent (seed multiplier)

No	Name of Selected Respondent	Year 2011				Year 2012				Year 2013			
		Area covered by seed potato (hectares)		Production (quintals)		Area covered by seed potato (hectares)		Production (quintals)		Area covered by seed potato (hectares)		Production (quintals)	
		Belge	Meher	Belge	Meher	Belge	Meher	Belge	Meher	Belge	Meher	Belge	Meher
1	Tesfaye Dembo	0.25	0.25	80	96	0.5	0.25	157	100	0.5	0.5	178	110
2	Boreko shollo	0.25	-	80	-	0.5	-	157	-	0.5	0.5	178	110
3	Bezabeh baruda	0.25	-	93	-	0.25	-	111	-	0.25	0.25	97	78
4	Matheos bonne	0.25	-	83	-	0.25	-	68	-	0.25	0.25	77	58
5	Africae zebela	0.25	-	55	-	0.25	-	61	-	0.25	-	48	-
6	Megerssa iemma	0.25	0.25	84	66	0.5	0.25	137	103	0.5	0.5	138	110
7	Dejene daka	0.25	0.25	70	46	0.5	0.25	122	89	0.5	0.5	89	65
8	Tesfaye shollo	0.25	0.25	102	88	0.5	0.25	162	79	0.5	0.5	96	45
9	Banda bullo	0.25	-	55	-	0.25	-	64	-	0.25	-	44	-
10	Tesfaye semo	0.5	0.5	200	181	0.5	0.5	165	133	0.5	0.5	144	92
11	Markosse waketo	0.25	-	73	-	0.25	-	68	-	0.25	0.25	72	55
12	Ketma deme	0.25	-	68	-	0.25	-	56	-	0.25	0.25	46	58
13	Chato cherbo	0.25	0.25	70	56	0.5	0.25	142	109	0.5	0.5	85	63
1	Dejennae	0.2	-	68	-	0.2	-	66	-	0.25	0.25	96	58

4	bonka	5				5							
15	Gobezae gomba	O.25	0.25	100	81	0.5	0.25	152	99	0.5	0.5	86	75
16	Desta denka	0.25	-	102	-	0.25	-	89	-	0.25	0.25	102	68
17	Kapeta konte	0.25	-	108	-	0.25	-	96	-	0.25	0.25	86	88
18	Debebe gade	0.25	-	104	-	0.25	-	84	-	0.25	-	63	-
19	Zado zegeyhu	0.25	-	101	-	0.25	-	77	-	0.25	-	54	-
20	Mamo durea	0.25	-	68	-	0.25	-	75	-	0.25	-	54	-
21	Tsegaye mengea	0.25	-	78	-	0.25	-	95	-	0.25	-	104	-
22	anbella tugea	O.25	0.25	71	59	0.5	0.25	130	119	0.5	0.5	95	103
23	Fachea fantaye	0.25	-	108	-	0.25	-	85	-	0.25	-	88	-
24	Aremede anbella	0.25	-	118	-	0.25	-	95	-	0.25	-	98	-
25	Fasha falle	0.25	-	128	-	0.25	-	99	-	0.25	-	58	-
26	Wagala wareza	0.25	-	88	-	0.25	-	109	-	0.25	-	100	-
27	Kabiso kabera	0.25	-	68	-	0.25	-	120	-	0.25	-	60	-
28	Buretae buhae (f)	0.25	-	92	-	0.25	-	85	-	0.25	0.25	61	70
29	Wanbae waze (f)	0.25	-	123	-	0.25	-	96	-	0.25	0.25	56	71
30	Meskobe mena (f)	0.25	-	108	-	0.25	-	88	-	0.25	0.25	86	53
31	Tsenta tsera (f)	0.25	-	98	-	0.25	-	66	-	0.25	0.25	55	60

Table Continued

No	Name of Selected Respondent	Year 2012				Year 2013				Year 2014			
		Area covered by seed potato (hectares)		Production (quintals)		Area covered by seed potato (hectares)		Production (quintals)		Area covered by seed potato (hectares)		Production (quintals)	
		Belge	Meher	Belge	Meher	Belge	Meher	Belge	Meher	Belge	Meher	Belge	Meher
32	Kaffeso kellea (f)	0.25	-	80	-	0.25	-	107	-	0.5	-	188	-
33	Berhanea betu (f)	0.25	-	45	-	0.25	-	54	-	0.25	-	98	-
34	Germu agena (f)	0.25	-	93	-	0.25	-	111	-	0.25	0.25	97	78
35	Amareche ame (f)	0.25	-	62	-	0.25	-	68	-	0.25	0.25	57	68
36	Gareto toba	0.25	-	55	-	0.25	-	61	-	0.25	-	48	-
37	Tadesse tamerat	0.25	0.25	85	69	0.5	0.25	127	103	0.5	0.5	118	110
38	Gezea gena	0.25	0.25	70	46	0.5	0.25	122	89	0.5	0.5	89	65
39	Shefenae doresa	0.25	0.25	100	88	0.5	0.25	112	79	0.5	0.5	106	115
40	Assefa ashageray	0.25	-	55	-	0.25	-	64	-	0.25	-	44	-
41	Gezahgne gamo >	0.5	0.5	200	171	0.5	0.5	155	123	0.5	0.5	154	99
42	Mezgea gezeto	0.25	-	75	-	0.25	-	78	-	0.25	0.25	95	55
43	Mena meze	0.25	-	69	-	0.25	-	66	-	0.25	0.25	56	58
44	Agena ara	0.25	-	70		0.5	-	142	-	0.5		105	-
45	Tsira tsaleka	0.25	-	68	-	0.25	-	76	-	0.25	0.25	106	68
46	Debaba doseka	0.25	-	100	-	0.5		122	-	0.5	-	76	-

47	Dare dulessema	0.25	-	92	-	0.25	-	89	-	0.25	-	112	-
48	Gameda garebo	0.25	-	68	-	0.25	0.5	96	-	0.25	0.25	106	98
49	Kersso garesho	0.25	-	94	-	0.25	0.5	104	-	0.25	-	63	-
50	Chosha chebero	0.25	-	101	-	0.25	0.5	117	-	0.25	-	54	-
	Total	13	3.5	4492	1047	16.25	5.0	4848	1225	16.25	10.75	4118	2302
	PRODUCTIVTY			345.54	299.14			298.34	245			253.42	214.14

Source: Own Field Survey

Appendix 2. Detail data on seed potato yield sampling

Table 5.7 Seed potato yield assessment based on sample taken

NO	RESPONDENT NAME WHERE THE SAMPL TAKEN	TOTAL AREA CULTIVATED FOR SEED POTATO	SAMPLE AREA AND NUMBER		YIELD FOUND PER SAMPLE AREA	YIELD FOUND PER HECTARE
			NUMBER	Area3		
1	Tesfaye Tole	0.25	3	4m2 4m2 4m2	8kg 9.2kg 11.7kg	200qn 230qn 292.5qn
2	Banda orcho	0.25	3	4m2 4m2 4m2	11.2kg 10.5kg 13.4kg	280qn 262.5qn 335qn
3	Tesfaye somo	0.25	3	4m2 4m2 4m2	7.7kg 10.9kg 12.6kg	192.5qn 272.5qn 315qn

4	*Markosse waketo*	*0.25*	*3*	*4m2* *4m2* *4m2*	*12.3kg* *13.9kg* *14.2kg*	*307.5qn* *347.5qn* *355qn*
5	*Ketma deme*	*0.25*	*3*	*4m2* *4m2* *4m2*	*11.9kg* *13.4kg* *13.okg*	*297.5qn* *335qn* *325qn*
6	*Chato cherbo*	*0.25*	*3*	*4m2* *4m2* *4m2*	*10.8kg* *9.6kg* *8.9kg*	*270qn* *240qn* *222.5qn*
7	*Dejennae bonka*	*0.5*	*3*	*4m2* *4m2* *4m2*	*11.okg* *9.7kg* *8.8kg*	*275qn* *242.5qn* *220qn*
8	*Gobezae gomba*	*0.25*	*3*	*4m2* *4m2* *4m2*	*11.3kg* *10.4kg* *12.7kg*	*282.5qn* *260qn* *317.5qn*
9	*Desta denka*	*0.25*	*3*	*4m2* *4m2* *4m2*	*7.0kg* *9.4kg* *9.0kg*	*175qn* *235qn* *225qn*
10	*Kapeta konte*	*0.25*	*3*	*4m2* *4m2* *4m2*	*14.2kg* *13.6kg* *13.9kg*	*355qn* *340qn* *347.5qn*
	Total	*2.75*	*30*	*120m2*	*334.2*	*278.5quintal per hectare*

SOURCE OWN FIELD SURVEY Dec, 2013

APPENDIX 3 production and productivity of ware potato DATA COOLECTED FROM 50 WARE POTATO PRODUCERS

Table5. 8 production and productivity of ware potato

No	Name of Selected Respondent	Year 2011				Year 2012				Year 2013			
		Area covered by seed potato (hectares)		Production (quintals)		Area covered by seed potato (hectares)		Production (quintals)		Area covered by seed potato (hectares)		Production (quintals)	
		Belge	Meher	Belge	Meher	Belge	Meher	Belge	Meher	Belge	Meher	Belge	Meher
1	Tesfaye Dembo	0.125	0.125	10	9	0.5	0.25	158	72	0.115	0.125	7.3	8
2	Boreko shollo	0.125	-	11	-	0.5	-	112	-	0.125	0.105	7	6.6
3	Bezabeh baruda	0.200	-	18	-	0.25	-	74	-	0.225	0.25	10	20
4	Matheos bonne	0.200	-	17	-	0.25	-	22	-	0.250	0.25	44	34
5	Africae zebela	0.100	-	6	-	0.25	-	15	-	0.250	-	38	-
6	Megerssa iemma	0.100	0.125	8.3	10	0.5	0.25	45	12	0.225	0.5	40	35
7	Dejene daka	0.060	0.125	5	7	0.5	0.25	37	15	0.215	0.5	12	38
8	Tesfaye shollo	0.090	0.125	9	7.8	0.5	0.25	23	14	0.215	0.125	13	10
9	Banda bullo	0.085	-	7	-	0.25	-	16	-	0.125	-	7	-
10	Tesfaye semo	0.090	0.5	8	54	0.5	0.5	33	28	0.125	0.125	8	6
11	Markosse waketo	0.060	-	6	-	0.25	-	39	-	0.125	0.25	9	13
1	Ketma deme	0.0	-	8.5	-	0.2	-	33	-	0.22	0.25	15	16

2		85				5				5			
13	Chato cherbo	O.150	0.125	10	7.2	0.5	0.25	31	15	0.225	0.5	16	33
14	Dejennae bonka	0.150	-	11	-	0.25	-	12	-	0.215	0.25	16	15
15	Gobezae gomba	O.125	0.125	9	7.2	0.5	0.25	67	14	0.115	0.115	7	8
16	Desta denka	0.150	-	9.7	-	0.25	-	13	-	0.205	0.25	11	15
17	Kapeta konte	0.090	-	7.7	-	0.25	-	14	-	0.205	0.25	12	13
18	Debebe gade	0.060	0.085	6.4	5.4	0.25	-	14	-	0.225	-	10	-
19	Zado zegeyhu	0.085	0.125	7.3	8	0.25	-	16	-	0.125	-	12	-
20	Mamo durea	0.100	0.125	6.5	9	0.25	-	17	-	0.125	-	9	-
21	Tsegaye mengea	0.200	-	15	-	0.25	-	18	-	0.125	-	8	-
22	anbella tugea	O.200	0.125	13	9	0.5	0.25	135	65	0.125	0.115	9	6
23	Fachea fantaye	0.090	-	6		0.25	-	40	-	0.125	-	8	-
24	Aremede anbella	0.060	-	5.8		0.25	-	21	-	0.125	-	8	-
25	Fasha falle	0.150	-	8.7		0.25	-	17	-	0.100	-	7	-
26	Wagala wareza	0.085	-	7.1		0.25	-	15	-	0.100	-	9	-
27	Kabiso kabera	0.125	0.200	27		0.25	-	14	-	0.100	-	6	-
28	Buretae buhae (f)	0.100	0.60	24.7		0.25	-	11	-	0.100	0.25	6	12
29	Wanbae waze (f)	0.125	-	31.3		0.25	-	15	-	0.125	0.25	10	13
30	Meskobe mena (f)	0.100	-	33.3		0.25	-	17	-	0.205	0.100	14	6
31	Tsenta tsera (f)	0.150	-	4o.7		0.25	-	18	-	0.205	0.100	13	6

Source: Own Field Survey2014

Table5. 8 continue

No	Name of Selected Respondent	Year 2012				Year 2013				Year 2014			
		Area covered by seed potato (hectares)		Production (quintals)		Area covered by seed potato (hectares)		Production (quintals)		Area covered by seed potato (hectares)		Production (quintals)	
		Belge	Meher	Belge	Meher	Belge	Meher	Belge	Meher	Belge	Meher	Belge	Meher
32	Kaffeso kellea (f)	0.060	-	3	-	0.120	0.250	6	13	0.150	0.205	8	7
33	Berhanea betu (f)	0.090	-	4	-	0.254	0.133	11	10	0.150	0.205	10	8
34	Germu agena (f)	0.200	.100	13	6	0.156	0.145	10	11	0.150	0.225	9	7
35	Amareche ame (f)	0.150	-	10	-	0.222	0.123	9	10	0.150	0.125	7	6
36	Gareto toba	0.150	-	9	-	0.100	-	5.6	-	0.150	0.125	8	6
37	Tadesse tamerat	0.060	0.125	4	11	0.111	0.25	6	12	0.150	0.125	10	7
38	Gezea gena	0.090	0.125	5	7	0.100	0.25	6.5	12	0.150	0.125	12	7
39	Shefenae doresa	0.090	0.125	5	6	0.100	0.25	6.5	12	o.111	0.125	10	7
40	Assefa ashageray	0.085	-	6	-	0.100	-	6	-	0.250	0.125	11	8
41	Gezahgne gamo >	0.125	0.5	8	33	0.250	0.5	13	32	0.090	0.100	6	5
42	Mezgea gezeto	0.125	-	7	-	0.133	-	9	-	0.090	0.100	7	5
43	Mena meze	0.125	-	7	-	0.145	-	8	-	0.070	0.100	4	5
44	Agena ara	0.200	0.100	12	6	0.123	-	10	-	0.600	0.100	5	
45	Tsira tsaleka	0.200	-	12	-	0.250	-	12	-	0.111	0.125	7	12
46	Debaba doseka	0.090	-	6	-	0.250	-	12	-	0.100	0.205	6	
47	Dare dulessema	0.085	0.090	7		0.166	-	10	-	0.125	0.205	5	8

48	Gameda garebo	0.100	-	5.5	-	0.541	0.5	33	28	0.200	-	11	-
49	Kersso garesho	0.125	-	6.5	-	0.333	0.5	20	31	0.100	-	6	-
50	Chosha chebero	0.150	-	8	-	0.250	0.5	18	32	0.111	-	6	-
	Total	3.87	3.675	491.3	193.6	13.704	5.651	1323.6	438	7.992	6.98	549.3	411.6
	PRODUCTIVTY OF WARE POTATO			126.95	52.68			96.58	77.51			68.73	58.97
	AVERAGE LAND [FARM] SIZE PER HOUSEHOLD	0.0774	0.0734			0.274	0.113			0.159	0.139		

Source: Own Field Survey2014

Appendix 4 samples on ware potato yield assessment

NO	RESPONDENT NAME WHERE THE SAMPL TAKEN	TOTAL AREA CULTIVATED FOR SEED POTATO	SAMPLE AREA AND SIZE		YIELD FOUND PER SAMPLE AREA [4m2] kg	YIELD FOUND PER HECTARE quintal
			size	Area		
1	Tesfaye Tole	0.125	3	• 4m2 • 4m2 • 4m2	• 3.00 • 2.65 • 1.94	• 75 .00 • 66.25 • 48.5
2	Banda orcho	0.100	3	• 4m2 • 4m2 • 4m2	• 2.88 • 1.65 • 2.94	• 72.00 • 41.25 • 73.5
3	Tesfaye somo	0.150	3	• 4m2	• 4.43	• 110.75

				• 4m2 • 4m2	• 3.65 • 1.44	• 91.25 • 36.00
4	Markosse waketo	*0.125*	*3*	• *4m2* • 4m2 • 4m2	• *3.80* • 2.35 • 3.94	• *95.00* • 58.75 • 98.50
5	Ketma deme	*0.200*	*3*	• *4m2* • 4m2 • 4m2	• *3.33* • 1.45 • 1.94	• *83.25* • 36.25 • 48.50
6	Chato cherbo	*0.200*	*3*	• *4m2* • 4m2 • 4m2	• *2.80* • 2.65 • 1.94	• *70.00* • 66.25 • 48.5
7	Dejennae bonka	*0.500*	*3*	• *4m2* • 4m2 • 4m2	• *2.00* • 2.55 • 2.94	• *50.00* • 63.75 • 73.50
8	Gobezae gomba	*0.150*	*3*	• *4m2* • 4m2 • 4m2	• *3.25* • 3.30 • 3.45	• *81.25* • 82.5 • 86.25
9	Desta denka	*0.100*	*3*	• *4m2* • 4m2 • 4m2	• *3.00* • 2.65 • 4.00	• *75.00* • 66.25 • 100.00
10	Kapeta konte	*0.100*	*3*	• *4m2* • 4m2 • 4m2	• *4.05* • 4.65 • 4.94	• *101.25* • 116.25 • 123.50
	Total	*1.75hec*	*30*	*120m2*	*89.56* 74.65	*2239 quintal per 120m2*
		0.175 Hec/HH			*74.65*	*74.63qn/Hec*

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