

**Community Led Potato Seed Production, Multiplication and
Distribution in Potato Growing Areas of Eritrea**

Light Case Study

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Countries/Regions Involved
Eritrea (Central Highlands)

Main Commodity Chain Addressed
Seed Potato Commodity Chain

1. Introduction and Background

Potato (*Solanum tuberosum*) is one of the most important crops in the world today. Potato produces more protein and calories per unit area, per unit time, and per unit of water than any other major plant food (Villamayor, 1984, Guenther, 2006). It is considered to be the most important vegetable crop, and is ranked fourth after rice, wheat and maize in terms of total production of fresh weight (Tadesse, 2000).

Potato arrived late in Africa - around the turn of the 20th century. In recent decades, production has been in continual expansion, rising from 2 million tonnes in 1960 to a record 16.7million tones in 2007 (FAO and CFC, 2011). In Eritrea, the potato crop has been cultivated for decades, but no records exist today as to which varieties were imported in the earlier periods. The farmers have their own identification systems based on the place of origin, place of intensive cultivation and also on the basis of morphological characteristics such as flower colour and shape of tubers (Biniam, 2006).

The objective of this case study is to generate the scientific agenda for a large and long-term cooperative scientific program shared between Eritrea and other countries in support of sustainable potato seed production and distribution systems in Eritrea.

2. Context Description and Literature Review

2.1 Potato growing conditions in Eritrea

Potatoes are grown under a wider range of altitudes, latitudes and climatic conditions than any other major food crop. They are grown from sea level to over 4,000 meters' elevation and from the equator to more than 40 degrees north and south. The diversity of the agro-ecological adaptation of potato practically defies classification (Beukema and Van der Zaag, 1990).

Most of the climatic conditions of Eritrea are favorable for all-year-round potato production in the highlands and midlands; however, potatoes are mainly cultivated in the high altitude and mid-latitude areas, ranging from 1,500M to 2,500M above sea level. The months from November to mid-February are the coolest months (night temperature below 10°C) in the high lands and hence most of the highland farmers do not grow potato during these extremely cool months. By contrast, in the mid lands, most of the farmers grow potato throughout the year, but usually the yield in the summer and cool months is low due to high infestation of pests as well as low temperature (Ali, 2007).

Potato grows in a wide range of soil types globally, ranging from sandy soil to clay soils and these soil types are also found in Eritrea. In Eritrea, potato is mainly grown on loam and clay

soils. The major production of potato comes from the regions with clay soils (Debub). Ninety percent of the potato growing areas in the Debub region have a clay soil, whereas the soil type is mainly a loam in the Maekel Region (Vita, 2013).

The western parts of Zoba Debub and N/R/S represent mid lands and are the most suitable potato production areas; but the N/R/S has a long dry season and results in one potato growing season. All parts of Zoba Maekel are suitable for potato production (Azieb *et al.*, 2011). Anseba and Gash barka are the regions where the potato is grown in small areas bordering the Maekel and Debub region, which is the smallest confined area. The potato has also the potential to grow in the larger parts of the western lowlands (Gash barka & Anseba) (**Figure-1**) bordering Ethiopia and Sudan using lowland potato varieties (Horticulture Research Report, 2010).

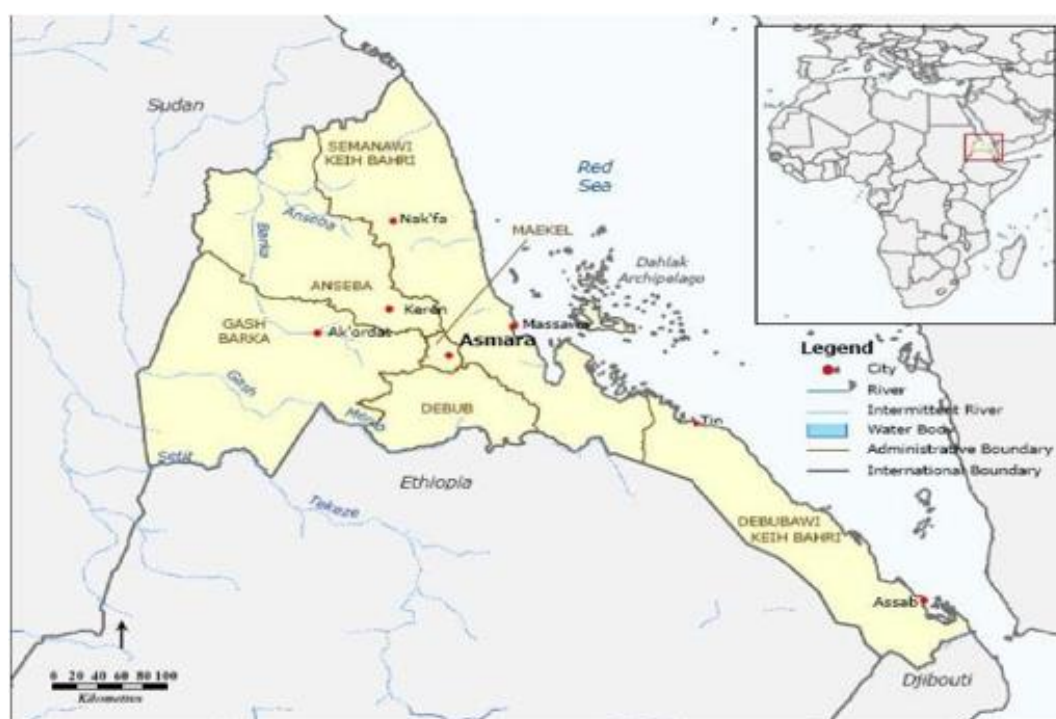


Figure-1 Eritrean Map

Source: Country profile-Hagere Ertra)

2.2 Area and production level of potato in Eritrea

Estimates by the Ministry of Agriculture Planning Office (MoA) 2015 indicate that the total potato production average of the 10 years (2005-2014) was 35,455.3 tons from an area of 2724 ha with an average yield of 12.98 tons/ha (**Table-1**). Most of this yield is obtained under irrigation, but is still below the world average (19t/ha) and African average (12t/ha in 2008) (International Potato Center, 2012). Yields also vary between seasons.

Table-1. Area, production and productivity of potato in Eritrea (2005-2014).

Years	Area (ha)	Production (tons)	Yield (t/ha)
2005	3091	38948	12.6
2006	2710	31261	11.54
2007	2382	32086	13.47
2008	2854	30309	10.62
2009	1744	18571	10.65
2010	2566	32551	12.69
2010	2357	33713	14.3
2011	2632	44939	17.07
2012	3163	46008	14.55
2013	3741	46167	12.34
2014	3091	38948	12.6
Total	27240	354553	129.83
Mean	2724	35455.3	12.98

(Source: Ministry of Agriculture Planning Office of Eritrea, 2015)

2.3 The role of farm size and land tenure systems in potato seed production

Generally, in Eritrea, and specifically in the project area, the land tenure and acquisition systems are Risky (individually owned), Diesa (communal), rented and/or shared (between contractor and owner). In the majority of the country's highlands or the potato growing areas, the Diesa system is predominantly practiced. The main characteristics of the system is that the land is basically owned by the community, thus every permanent resident is entitled to share it equally through a periodic redistribution (usually every 7 years) to all community members (Negassi, *et al.* 2002). In other words, farmers only have the right to cultivate the land but not own it. But still farmers can obtain additional farmland through a variety of tenancy arrangements (Tewolde and Ghebreyohannes, 2003). The Diesa system is criticized for not encouraging growers to put long-term investment into the land as they know it will be redistributed to others after a certain interval, although it provides equitable access to all members (NFIS, 2005; Negassi, *et al.*, 2002).

There is also one land tenure system called conscione, which is owned by individuals introduced during the Italian colonization and the land belongs to individuals forever. Here individuals are encouraged to make long-term investment in the land (Azieb *et al.*, 2012). This system is more applicable for potato seed production systems.

The 2012 potato survey in the Maekel region indicated that 44 per cent of farmers in potato production had an area below 1ha followed by owners of 1-2ha (36%), <2 to3 (14%) and above 3 (6%) (Azieb *et al.* 2012). Similarly, the findings from the Potato Evaluation Survey 2013 indicated that the average area of land allocated by farmers for potato in the regions of Debub and Maekel is about 1.5ha (Vita, 2013). Biniyam *et al.* 2014 reported that about 62% of the growers allocate part of their land for potato growing during the rainy season and about 93% during the off-season.

Measures should be taken to improve the land tenure system that hinders long-term investment so as to improve productivity. In the 2013 potato evaluation survey, 75% of the respondent potato farmers had a concern on this issue.

Therefore, greater security of land tenure system may help to increase sustainable potato seed production, multiplication and distribution systems in Eritrea.

2.4 History of potato seed importation and distribution systems in Eritrea

Before independence (before 1990), Eritrea was under full control of colonizers and no record or documentation exist regarding potato importation and distribution. After independence, starting from 1993, the Ministry of Agriculture of Eritrea commenced importing bulk amounts of potato seeds, mainly from Holland. (**Table-2**). (AGRICO).

Table-2- Potato seed tubers imported and distributed in country during the years 1993-2009

Sn	Year	Potato varieties	Amount (Tons)	Distributed to (Region/Zoba)	Source	Funded
1	1993	Kara	NA	-	Holland	
2	1994	Diamond	NA	-	Italy	
3	2000	Spunta	NA	-	Holland	
4	2002	Desiree Ajiba	120	Debub, Maekel, Anseba and N/R/sea	Holland	Danida
5	2002	Cosmos	50	Debub	Stet Holland	FAO
6	2003	Timate Farmer Ajiba	232.2	Debub, Maekel and Anseba	Holland	Emergency Rehabilitation Program (ERP)
7	2004	Ajiba Spunta	100	Debub (including research), Maekel	Holland	ERP-African development bank
8	2004	Cosmos	10	Research (NARI)	Holland (AGRICO)	CHIHDP
9	2005	Cosmos Ajiba	168.8	Research, Debub, Maekel & Anseba	Holland (AGRICO)	CHIHDP
10	2008	Ajiba Spunta	200	Debub	Holland	Care international
11	2009	Ajiba Spunta	200	Debub	Holland	Oxfam UK
12	2009	Ajiba, Cosmos Spunta	373	Debub, Anseba, Maekel & Gash Bark	Holland UK	FAO

(Source: Secondary data collected from Horticulture unit at MOA in 2013)

Note: NA = Not available

Potatoes were imported through Ministry of Agriculture extension agent and then distributed to different regions of the country. The importation was usually done according to the demand of farmers to boost their production and satisfy consumers. In some years, there was a consecutive importation of basic and certified potato seeds e.g. 1993-1994, 2000-2005. Importation ceased during the years 1997-2000 due to the war between Ethiopia and Eritrea.

In the 1990's and early 2000's, the flow of potato seed distribution in most regions of Eritrea through aid programs was extremely high and it continued until 2005. However, the flow was not consistent in supplying good seed to all the farmers. In 2003, the national research organization became involved in the multiplication of the promising varieties as basic seed

and distributed it to seed growers, who, in turn, distributed it to commercial farmers. This continued until 2007. From 2007 onwards, the seed provision system was extremely poor. The availability of good seed was rare in most regions of Eritrea. Farmers requested the Ministry of Agriculture to provide them with improved seeds but the response was not usually positive. In some years, such as 2009, seeds were imported but farmers were not satisfied with the quantity and quality of the tubers. Then the growers started to introduce varieties from the neighboring countries. The varieties were imported from unknown sources with no certification. Quality control mechanism for this kind of seed importation systems was poor. The Community-led Potato Seed Production, Multiplication and Distribution project seeks to establish the seed production and supply system in an appropriate way.

2.5 Potato varieties used and seed access in Eritrea

Earlier the potato seeds used consisted of a mixture of many varieties, both from locally grown and varieties which were imported from time to time. The imported varieties give a very high yield in the first season as compared to the locally available varieties, but in the second and third generations they become severely degraded and yield is very low.

Locally available potato seed cultivars include Karneshim, Serejeka, and Shashemene, Israel, Tsada Embaba and Kei Embaba. Farmers commonly name them after the place they are imported from. Some, like Serejeka, are called by the name of the place they are used in the most. These varieties have been produced for a long time. Their consistency in yield over a long period suggests their adaptability to the local conditions but the yields produced from these varieties was very low (Biniam, 2006).

Since 2000, the Ministry of Agriculture has imported many known varieties to evaluate in research and also multiplying basic seeds such as Ajiba, Desiree, Cosmos, Farmer, Timate, Spunta, Cara and Kondor from Europe (Ali, 2004). Some years later, in 2009, varieties like Picasso and Zafira were introduced and produced remarkable performance. Hence the Ministry of Agriculture have imported bulk amounts of certified seeds of these varieties and then distributed them to farmers (MoA Report, 2011). In 2013, six varieties namely Electra, Buren, Banba, Orla, Savanna and Slaney were imported from Ireland and have been tested at the NARI Research Station and on-farm. Electra was selected as a promising variety (Horticultural Research Report, 2014). At present, Electra is the current outstanding variety that exists in the current pilot Community Project. (Vita, 2015).

In the absence of any national formal seed provision system, the normal practice for farmers is to either save the smallest sized tubers for seed in the next season or to simply buy small tubers and left-over tubers from the vegetable market (Ali, 2004). Currently, the seed growers/farmers are using potato tuber seeds from legally imported supplies (Ministry of Agriculture) and some of them import from unknown sources. However, a potato survey carried out in 2013 indicated that out of 25, 14 farmers (96%) were used imported varieties from neighboring countries because the Ministry did not provide enough seeds to the beneficiary farmers (Vita, 2013).

2.6 Sale, marketing and consumption of potato in Eritrea

Small farmers bring their product to the nearby market or traders collect the produce from the small farmers and take it to the main city or export it to Sudan. But the commercial farmers supply the product to the main city or export it to Sudan directly. Here the market actors, namely producers, collectors, wholesale traders, retailers and consumers play different roles along the market chain (Vita, 2013).

Many developing countries face product market constraints. Eritrea is not an exception. The road infrastructure is not well developed and the country is still trying to build basic infrastructure works for food security.

In Eritrea, there is no definite market channel. Some farmers are involved in all the channels, but others may use only one channel. The Potato Survey of 2013 indicated that farmers sell the bulk amount of their potato product (>70%) to the market, (20-30%) for their own saved seed and the remainder (5% or less) is used for home consumption. The ratio of home consumption to sale was 1 to 25. Damaged, very small in size, or insect infected potatoes are used for home consumption by most of the respondents (95%).

Prices of potato product fluctuate between or within years for the following reasons. The source of seed of potato is usually unknown. Some of the years, ample amounts of potato seeds would be imported from abroad and a lot of farmers receive it and produce high production. But in some years, seeds are not readily available, resulting in low production and leading to increased prices. The existing variation in weather conditions escalates the production difference. In 2013, the price of potato ranged from 20-50 Nakfa per kg (Vita, 2013). Similarly, during the project period in the year of 2015 it ranged from 30-50 Nakfa/kg (**Table-3**) (MoA, 2015).

The world and Africa potato consumption in 2007 were 32 and 14 kg per capita per year, respectively (Lekgau and Jooste, 2013), which is higher than the current potato consumption in Eritrea at 10 kg per capita per year (Vita, 2015). In Eritrea, all consumption is of unprocessed potato, which is eaten cooked. A small amount of processed potato products are imported from abroad, but are only affordable by high income groups.

Table-3 Monthly prices (Local market) of potato in Eritrea in 2015

Sn	Months	Prices (Nakfa/kg)	Remark
1	January	33	Cool winter
2	February	37.5	Cool/warm winter
3	March	35	dry winter
4	April	39	Spring
5	May	35	Spring
6	June	40	Rain start
7	July	50	Summer
8	August	40	Summer
9	September	30	Rain end
10	October	38	Autumn
11	November	40	Cool
12	December	42	Cool Autumn

(Source: MoA Annual Report Planning Office, 2015)

In Eritrea both men and women are equally involved in potato marketing.

2.7 Potato storage

Farmers use simple storage practices for seed. After harvesting the tubers, farmers select medium sized undamaged tubers that are free from pests for seed. Immediately after sorting, they collect the seed and spread it on the ground for 10-15 days after which they collect it again in jute sacks or boxes. But some farmers do not put them in jute sacks or boxes, but leave them inside house on the floor. Similarly, some spraying can be practiced against insects. Chemicals such as Malathion and sevin are sprayed on a regular basis. All the improved varieties imported are stored in centralized stores of the Ministry of Agriculture located in Maekel (Tsadachristian and Serejeka), in Debub (Halhale and Adi zarna) (Vita, 2013). Totally all these stores have a capacity of 400 tonnes of potato seeds. Currently, all these stores need renovation and rehabilitation. At present, one big centralized store located in Debub region is under construction. However, there is not any storage structure for ware potato. Farmers sell their product immediately after harvesting to the market.

3. Intensification Pathways- Adoption of Innovation

Multiple entry points and pathways to intensification exist in a given context. The science base differs between the pathways; some having been on the agenda for many decades, others being more recently explored. Pathways have different characteristics with respect to technical performance but also in terms of knowledge, skills, resources, and time requirements; constraints and risks, and cost/benefit streams. Crossovers between pathways are less researched. A high degree of coordination and cross-learning is required of the national and international science communities to have a balanced approach to intensification pathways and not oversell some concepts.

Many of the challenges facing agriculture currently and in the future will require more innovative and integrated applications of existing knowledge, science and technology (formal, traditional and community-based), as well as new approaches for agricultural and natural resource management.

Innovation is at the heart of sustainable intensification and will help the Eritrean potato farmers produce more with less impact on the environment while also improving sustainability. Much of this can be achieved by utilizing existing knowledge, either imported from outside or indigenous sources, but because of the nature and scale of the challenges it requires innovation.

The Eritrean seed production system involves various stakeholders, and so intensification pathways must be considered in their social, economic and policy dimensions, scrutinizing the changes required in the enabling environment, the interactions between all stakeholders in the main value chains, and identifying the effective drivers for change. The major actors in the value chain in Eritrea include researchers, extension agents, producers, traders (wholesalers, retailers, dealers, middlemen, brokers) and consumers. The major drivers for change of potato seed production are enormous, but include: appropriate technology packages (as improved storage facilities, irrigation scheduling, appropriate plant density), prevalence of diseases mainly viruses, and capacity of the farmers.

3.1 Improved vs traditional varieties:

Farmers are happy to use improved and imported varieties for high yields. On the other hand, the imported varieties degenerate following two or three years of growing. The producers perceive that early generation is better than later generation seed by reason of being “younger.” One frequently cited benefit of early generation seed is higher yield potential. For those farmers who are interested in growing local varieties, they are not happy with the production because of the low yields. But with less resource management, local varieties do better than imported varieties. In addition, they have the advantage in resisting the external environment. Parallel with this, they are also preferred by consumers for their taste and ease of cooking. Most of the Eritrean potato farmers (90%) are definitely interested in the early maturing, high yielding and disease-resistance improved varieties.

3.2 The extension service:

Farmers are not happy with the current system of transferring knowledge and experience. The training delivered by extension agents is done indoors and is infrequent due to poor extension services. In addition, the capacity of the extension agents is also very limited because most of them are new graduates, according to the growers. The extension agents in the Ministry of Agriculture lack transportation to meet and supervise the farmers. This problem is completely solved in the new Community-led Potato project and at least nine technical visits were done per individual farm per one cropping season. They are very happy with the new method of extending the knowledge to their farm. The extension service mainly helps the beneficiaries to facilitate the provision of seeds, fertilizers, pesticides supplied by marketing and credit unit of the Ministry of Agriculture. The role of the Marketing and Credit unit is to supply agriculture inputs such as seeds, fertilizers, pesticides and other farm tools to the beneficiaries. It works with the revolving fund project.

In some periods, private sectors or non-government organizations played some greater roles in providing extension services but it was not sustainable. In addition, extension services have seen significant modifications in the way in which they are provided. Early approaches favored a top-down model where farmers were passive recipients of the 'knowledge' transferred by extension agents. Currently, with the Community-led Project, extension training has broadened in scope and is more relevant to the needs of sustainable intensification, covering issues such as potato agronomy, diseases and pest management, role of crop rotation on potato seed production systems, nutrition as well as more typical topics such as integrated pest management. It has also been built on participatory models, which treat farmers as more dynamic participants and sources of knowledge, or even as the trainers themselves.

3.3 Agronomic practices:

Adoption of best agronomic practices by producers improves quality and increases quantity of produce. Adoption of appropriate post-harvest handling practices and adequate storage by farmers helps ensure delivery of quality produce to wholesalers and retailers, increases the produce shelf life, reduces losses, and increases the income of actors.

As is widely recognized, inappropriate farming practices can lead to loss of nutrients, wastage of water, resulting in low and unreliable yields. This appears to be a long-standing traditional method of potato farming whereby farmers were using inadequate irrigation scheduling (over-irrigation) and broadcast application of fertilizers which were developed probably long ago. They believed that over-irrigation and excess application of fertilizers could increase yields. They said that if you applied excess amounts of farmyard manure, white fertilizer (Urea), you could see excess vegetative growth of the potato and eventually higher yield or bigger sized tubers. On the contrary, they stated that if you apply less farmyard manure and white fertilizer (Urea), production will be less. Of course, this is right: however, they never differentiated between those tubers planted for seed purpose and those for ware purpose. They use one growing technique and at harvest they start to select for seed and ware separately. With the new innovation, farmers use different growing technique for seed and ware potato.

The majority of the potato fields of the project area in Dehub region were exposed to excess irrigation; in some instances this was so severe that the crop was displaying evidence of nutrient leaching. Most of the interviewed farmers were using the same intervals of irrigation scheduling throughout the growing season. This is not correct and the pilot project tries to resolve the problem.

With this project, the selected farmers understand clearly that the main constraints on the generation of the potato tubers are viruses. Training was provided showing them exactly what virus symptoms looks like. Currently, the farmers themselves tried to differentiate viral diseases from other various types of diseases.

As part of the pilot project, seed growers receive agricultural inputs, fertilizers/pesticides and equipment for spraying from the Ministry of Agriculture. However, the potato producers consider access to input supply still insufficient. Earlier, in response, some non-government organizations created input supply networks by providing seeds and some equipment in the potato producing zones. The growers are not satisfied with the private input traders efforts to improve access to inputs. The availability of appropriate agricultural inputs, fertilizers, pesticides and equipment helps us to boost production and serves to improve our income, added the potato seed growers.

The existing or the traditional system was based on imported varieties propagated conventionally and used for some generation. It has two main disadvantages: on the one hand, after importing the tubers, they immediately deteriorated in a few generations and yield decreased from generation to generation. Secondly, it is much too expensive to import huge amounts of potato tubers. The new Tissue Culture technology which is located at the National Agricultural Research Institute of Eritrea was established some years ago and can produce mini tubers. The first mini-tubers are already transferred to the beneficiaries for seed multiplication.

3.4 Storage facilities:

It is obvious that farmers were engaged in traditional storage practices and most believe that improved storage is only applicable for developed countries. Of course, a small percentile of the farmers disagree with this idea. They need to own some of the improved structures. These farmers have some knowhow about new storage systems.

We have at least four centralized stores built by the Ministry of Agriculture. Their capacity is almost 400 tons of potato seeds. They are old, the materials are getting older. One of the objectives of this project is to rehabilitate them. Most of the time, a certified seed which is imported by Ministry of Agriculture is stored safely in these centralized stores until distributed to the farmers. Moreover, seeds collected from the seed growers also stored there until distributed to other beneficiaries. It helps the farmers to own healthy potato seed for the next generation. However, the capacity of the stores is very small they cannot hold the required amount of the seed.

In the potato project, some of the participating farmers (37%) own diffuse light stores which are built with simple local materials at low cost. Diffused light stores are built basically on the use of indirect natural light and good ventilation or air flow without the need to have a cold store to control excessive sprout growth and associated storage loss. The aim of potato seed storage in

diffuse light is to keep the seed in good condition until planting (International Potato Center, 2012; Michael, 1989). The farmers involved in the project really appreciated the simple diffuse light store design provided. The use of the new simple diffuse light store technology is better than the one they used, jute sacks and concrete floors. This will help them store their own clean potato tubers for the next generations. They added that the cost of store management reduced and post-harvest loss decreased when compared to the existing system.

However, some of the beneficiaries were not benefiting from the diffuse light store construction. We have an interest and potential to build stores, but the existing land ownership and land tenure system do not allow us to build the store on the farm, say ‘the beneficiaries’. The beneficiary address this issue to policy makers through extension agents or when policy makers visit their fields and eventually the dialogue is going on to resolve it.

3.5 Marketing issues:

Normally, the marketing system in Eritrea is weak. The producers usually connect with wholesalers in case of ware potatoes. For seed purpose, the Ministry of Agriculture is involved in buying the seed and after storing sell it to the beneficiaries.

For ware potato, traders negotiate and sometimes set the producers’ price by themselves. The producers claim that the price setting by the traders is not usually fair. Most of the time, traders do not consider the cost of production. The existing system of cooperation does not help the producer to set the selling prices of their product.

For the seed purpose, the Ministry of Agriculture agrees a contract agreement with the farmers to collect all the seed sized and clean seeds. In the new project, some criteria were included in the contract agreement such as that the seed should be free from virus diseases (tested in Tissue culture laboratory before it is collected) and the seed grower should be a potential farmer who benefits other farmers.

Traders, big hotels, and consumer prefer to have big sized white variety but producers prefer both medium sized and big sized tubers of white varieties. The red varieties are less preferred by consumers. Medium sized will be used for seed purpose and bigger sized tubers will be used for consumption. The farmers sell almost 70% of their product to the market (Vita, 2013). In this case, the existing system will go parallel to the new innovation practices.

In the new project, the marketing is still not well organized but in the next phase of the project this issue can be considered.

3.6 Productivity and production:

The existing yield recorded in Eritrea is almost 11-13 tonnes per hectare, which is below the world average (MoA Report, 2014). Most of the yield was obtained from the irrigated fields. The pattern of rainfall in Eritrea is erratic and uneven mainly due to climate change. Consequently, most of the farmers are currently practicing irrigation for the production of potato. In the new potato project, in the first cropping cycle, the yield increased to 35 tons per hectare and to 45 tons per hectare in the second cropping (Vita, 2015). This yield is remarkable and all the farmers were very happy to see that much increase in yield. This yield was obtained with clean seed, training and close supervision, and improved technology packages as an inputs.

A small case study report of one of the beneficiaries in the community-based potato seed production, multiplication and dissemination project is described below.

PROFILE OF POTATO BENEFICIARY- BEREKET TEWELDE



Bereket Tewelde, 54, is a potential farmer in Zoba Maekel. He has finished his middle school and then started to work in agricultural sites. He has been involved in farming for almost 30 years. He is a father of six children. He has 4.5 hectares of land where he grows potato, vegetables, tomatoes and cereals depending on the seasons. On the average, he earns 300,000 Nakfa annually.

He said that he has received 10.5 quintals of Electra variety. The seeds were planted in 0.5 hectare of land and the potato seeds were grown with good crop care management. He also added that he always adds

fertilizers, and applied pesticides based on the requirement.

“My biggest problem is of course the lack of certified seeds, insecticide and land. In 2014, he bought potato seeds from Sudan which were completely damaged seeds,” says Bereket. He said the Ministry of Agriculture has to provide quality seeds and check the seeds which are imported to the country.

“The seeds that I have received from the project, Electra, are in a very good shape and I produced very remarkable results which was approximately 150 quintals in the first harvest. In the second planting, I planted 25 quintals seeds from my own saved seeds and am harvesting it and have good instincts that they will be fruitful.



Moreover, he hires women and men to help him in cultivating potatoes and other vegetables.

In addition, I have water source and a tractor which are an advantage for me to be successful in my agricultural work,” adds Bereket.

He really appreciated the training that he received, especially the outdoor farm training in which he has got a lot of knowledge and inputs. Especially, the use of the new simple diffuse light store technology which is better than the one he used that is wooden boxes or Jute sacks. This will help him store his own clean potato tubers for the next generations.

He wants to own his own land and produce quality potato seeds for multiplication purposes. “There is a very good market for potato and other vegetables so I want to be a competitive farmer, though I believe extra work is needed plus trainings on how to use modern agricultural equipment and tools,” says Bereket.



To appreciate his work, a team composed of CEO VITA (John Weakliam), Teagasc (Larry O’Loughlin), Ray Jordan (Gorta SHA), farmers, research staff, extension agent and Eritrea Vita members all jointly visited when the second potato crop was harvested on 16 May 2016.

3.7 The major drivers for intensification of potato seed production in the potato value chains

-The introduction and development of improved and clean seed is at the heart of the potato intensification program in Eritrea

This is the most important factor in Eritrea and will also be the key driver of potato productivity in the central regions of Eritrea. This development entails increased variety evaluation trials and development of virus-free planting material from tissue culture. Research focusing on potato growing conditions has increased, thanks to the work of various partners, providing new hope for the potato sector transformation and development: -CIP (Potato International Center) for providing new breeding lines, European potato marketing companies such as AGRICO, IPM...etc. for working intensively to send varieties that do well in Eritrea. Investments in potato research by international organizations and local governments are highly beneficial to Eritrea. However, the importation of new potato varieties and production of virus-free mini-tubers (in Tissue culture) will not lead to transformation if national experts or stakeholders do not increase their efforts to promote the adoption of these varieties through effective extension services.

In addition, the traditional varieties have a wider adaptation compared to the newly introduced; therefore, it is necessary to clean the seeds from the virus load and use them as basic seed for multiplication. On the other hand, the improved ones produce good yields with intensive crop care management so they need very close supervision to produce good yields for long periods of time. For the degenerated mixed local cultivars, further breeding work is requested to purify them. Then the desirable traits can be identified and used for breeding purposes, or if the varieties are purified and a small amount of these best varieties can be procured and multiplied.

-Fertilizer and pesticide application as intensification drivers for potato commodity value chain transformation:

As soil fertility deteriorates, fertilizer use must increase. Normally, in Eritrea, in potato production two forms of fertilizers (as DAP and UREA) are widely used. No potash fertilizer is used at all. Earlier studies consider that Eritrean soils had enough potash. However, this is not right for potato, which requires high doses of potash. Farmers believe that high doses of fertilizer application increase potato yield. However, the right fertilizer form, with the right doses and at the right time increase potato productivity and yield. In addition to fertilizers, farmers need to protect their potato crops from insects (Aphids, tuber moths and white flies) and diseases (fungal diseases) through the careful use of insecticides and fungicides. This requires the Ministry to intervene to ensure availability of the right type of fertilizers and pesticides, at the right price, and at the right times. Of course, subsidies can be helpful, but strong governance and farmer education are both essential for success. Farmers field schools used for education and the provision of agricultural extension services are very beneficial for improving productivity and income. Furthermore, improved knowledge about the use of fertilizers and pesticides lessens their potential negative impact on the environment. The education system on application of fertilizers and pesticides is under way to the beneficiary farmers. Farmers are starting to improve their usage of fertilizers and pesticides in respect of doses and time.

Until now, the main supplier of fertilizer and pesticides to potato seed growers or multipliers was the Ministry of Agriculture. There are, of course, very limited small shops that sell fertilizers and pesticides in the towns.

-Prevalence of Viral Diseases

Eradication on controlling of viral diseases of potato is an intensification pathway that helps to produce virus-free tubers, greater yields, and higher net incomes while reducing over-reliance on pesticides used and reducing labor for regular spraying. One means of producing virus-free tubers is by planting the clean seeds in high altitudes with less aphid population, isolated places with close supervision. This is the only solution that clean seeds can be produced sustainably for long period of time. The established tissue culture laboratory in the National Agricultural Research Institute of Eritrea is capable of producing the disease-free mini-tubers. These mini-tubers are multiplied later at model farms.

The practices that need to be introduced in the production of clean tuber seeds in the farmer's field are positive and negative selections. These two selections are very helpful and practical in the farmer's field. The negative selection is being used in the existing new project.

-Crop rotation:

Crop rotation is one of the drivers for production of healthy potato seeds to be produced in Eritrea. Because it is essential to minimize build-up of soil-borne diseases and pests and to maintain adequate soil structure and fertility, it is particularly important to avoid problems mainly with bacterial wilt diseases such as brown rot and various species of nematodes. Farmers normally experience crop rotation differently depending on land holding sizes. Small scale farmers do not use the right way of crop rotation as compared to the commercial farmer. Therefore, to be sustainable, the model farms or big sized farms are more relevant to work with crop rotation than small scale farms. The project is working with big sized farms for production of healthy potato seeds. The small farms can be used for ware potato growing.

The newly introduced crop rotation protocol that has been incorporated into the potato project is very helpful for the success of the clean potato seed production and also contributes in the up scaling of the potato value chain.

-Building storage facilities

The existing centralized stores owned by the government contribute to keeping the newly imported potato seeds until they are distributed to the beneficiaries. However, these stores need some maintenance. The diffuse light stores developed with the potato project and which are owned by individual farmers can play a great role in the successful storage conditions of the clean seeds to be harvested from individual farms.

-Strengthening Market linkages

With greater intensification of market linkages comes a heightened awareness of value chains and of the need to shift more of the value of produce to the hands of the farmers who produce it. Far too often for smallholders participating in the chain, the rewards are low and the risks are high. Often the situation is made worse by middle-men in the market chains who transfer the risks to those with the least power, namely the smallholder farmers. In this context, farmers' associations employ economies of scale to reduce risk and maximize collective incomes. Cooperatives are usually formal and registered. In Eritrea, the potato production center is not far from the cities and this is an advantage to make the market actors linkage stronger. The cooperatives have their own role and regulations considering the market issue

but are not yet functional and hopefully some improvement can be achieved with the new project.

-Improved communication among the stakeholders

To improve the linkages between production, market and value chain actors, a potato seed production stakeholders' forums should be established. Linkages created during trade fairs, stakeholders forums and field demonstrations helped improve farmers perception of a "seed potato" and other technologies. To farmers, any tuber from whichever source was equally good for planting, but with the project's awareness creation, they started demanding quality seed from a reputable source.

4. Opinion from Stakeholders in considered value chains

Discussions with all stakeholders disclosed that there is a shortage of local and improved seeds in the target areas. It was also noted that the improved potato tuber had received wider acceptance. The provision of certified/improved seeds will be crucial for raising the potato productivity and production of the targeted areas that requires intensification. In this case, large scale potato producers in the project area can offer opportunities for seed multiplication. Hence, options at establishing a seed multiplication mechanism need to be explored.

The transfer of the concept of knowledge to local expertise and farmers that will help them in the application of best practice approaches in innovation as well as research-extension linkages is of great importance to Eritrea to strengthen its extension system. Thus, the Ministry of Agriculture, particularly agricultural extension agents and the National Agricultural Research Institute, should strengthen and make linkages with the Irish agriculture research-extension service (Teagasc) to develop the skills of local staff.

In Eritrea, the value chain actors are not integrated in ways which would facilitate market information exchange on the quality and variety of potatoes demanded. Furthermore, potato supply is not consistent throughout the year, peaking from March to June; October-November and bottoming out between July-August; December-February. This needs a joint meeting and analysis of the situation to develop a plan which would help to strengthen the potato value chain.

Networking between producer, buyers and input suppliers will help producers run sustainable enterprises. In the case of Eritrea, this networking is very complicated and is not standardized. The producers do not have a direct link to wholesalers or retailers.

The existing cooperative, or farmer organization, owns offices but is still not functional. The beneficiaries rarely receive seeds, fertilizers or chemicals from the association. This needs to change and the cooperative must grow strong for the success of the value chain. It should work mainly for the benefit of each member. The new project has helped establish some groups on a regional bases. This is showing the stakeholders how to identify the main gaps, challenges, and risks associated with cooperatives.

There is one college of agriculture in Eritrea which contributes to sending graduates to farming areas. The college has a mandate to familiarize students with the producers before graduating from the college. Field trips are arranged to farms before graduation. But this is not enough to enable the graduates to work independently. Therefore, there is a need to upgrade the skills of these graduates as well as the skills of the farmers.

Researchers have a mandate to screen varieties and develop disease-free materials and they are expected to work directly with extension agents. The research-led project which is currently in place reflects the outcome of the strong linkage between the researchers and extension agents. Researchers always wish to see innovations adopted by the producers. Moreover, researchers like to link research results up to the consumers. The current project will help to create a conducive environment on farms by adopting appropriate technology practices before releasing the disease-free mini tubers.

Potato processing is not practiced in Eritrea unlike in well-developed countries. Only small scale chip processing and cooking of exist. Even some supermarkets are preparing chips for sale due to the absence of processing industries. The majority of Eritreans consume potato, but consumption could be higher.

5. Impacts from considered intensification pathways

The potato seed growers recognize that the management of their crops has improved as the result of the training programs held under the current project. They stated that the training on the prevalence of viral diseases, improved storage practices, appropriate cultural practice managements, and potato seed production and supply systems had resulted in enabling them to work independently at their plots.

Contracted farmers benefited in terms of increased income; improved access to assured markets and often higher prices than in open markets; better access to credit facilities; regular extension advice; and coordinated transport arrangements. Coordinated deliveries of potatoes accompanied by indicating farmers' details and assert responsibility of farmers to supply quality tubers.

Because potato cultivation is management intensive as yields increase, the labor requirement will also increase, so sustaining the potato sector is among the most effective employment programs that the policy could plan.

The policy makers usually address the improvement of the welfare of potato-farming families and potato consumers by improving the productivity of the potato sector and its ability to produce good quality potatoes at an affordable price while protecting the environment.

6. A proposed research agenda

A proposed research and innovation agenda will ultimately enable stakeholders to develop and compare on going and emerging potato seed production and multiplication intensification pathways in important potato value chains in Eritrea. Several concepts have to be clarified to face the challenges of the value chain.

In the first phases of the project, the main focus was to establish the potato seed growers cooperative. These growers have an obligation to produce clean seed for wider dissemination. Therefore, specific criteria were set for the success of the clean seed production. The project provides clean seeds, supervises and follows the potato seed growers, and evaluated the outcomes In addition, the project area also evaluated whether it is fit or not for potato seed

production in the next planting considering the viral diseases. Parallel with this, the tissue culture laboratory in the National Agricultural Research Institute received some materials from this project and helped it to work independently to produce disease-free planting materials. This planting material will be provided to the farmers who are already involved in the project.

Therefore, the main proposed research agenda should be to focus on the continuation of this project and to upscale it. Value chains should be considered by adding some activities which were not included in the tasks already performed. The setup is described as follows:

I. Improve the varieties and seed offered to Potato farmers

✚ Accelerated potato variety selection:

New varieties will be imported as basic seeds and tested at research and on-farm. Based on the results obtained, promising varieties that meet the Eritrean conditions will be released to farmers. This will help to have more available outstanding varieties in Eritrea. Farmers are already requesting to have more outstanding varieties.

✚ Increased production of basic seed:

Basic seed or mini-tubers will be developed at NARI and multiplied by specific outstanding farmers. Then, the increased amount of certified seeds will be widely distributed to more farmers in the project area. Hence, within the territory of potato crop cooperatives the focus will be on the development and dissemination of adaptable potato varieties as well as expansion of research on potato through Tissue culture development.

II. Capacity building

➤ Farmer training:

Farmer training is one of the main agenda items of the project. In the first stage of the project, a small number of farmers were trained by extension agents. Those trained farmers were the model farmers who are able to train other farmers. Parallel with this, the way of extending the knowledge to farmers can be done more widely in and outside of the project area. It should be more practical if it done on the farm. The participation of women on the potato seed production activities is enormous and hence they will be the main target beneficiaries in the next phase of training. On-going dialogue and research initiatives at the national level reveal the need for evidence-based research which shows the benefit of mainstreaming gender in the planning and implementation of potato seed production, multiplication and dissemination projects.

➤ Research and extension staff training

In the first phase of the project, staff from research and extension staff were trained. Similarly, the training will continue with new technologies. More training materials will be prepared and provided to the trainees. To fill the gap of inexperienced new graduates from the agricultural college, practical training will be provided. This will be replicated across the country.

III. Improved management practices:

Support the development and transfer of production technologies for improvement of potato seed production. Under this activity, the farmers inside and outside the project area will be the

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beneficiaries from the developed production technologies. All the farmers will incorporate the new technology on their farm for better production.

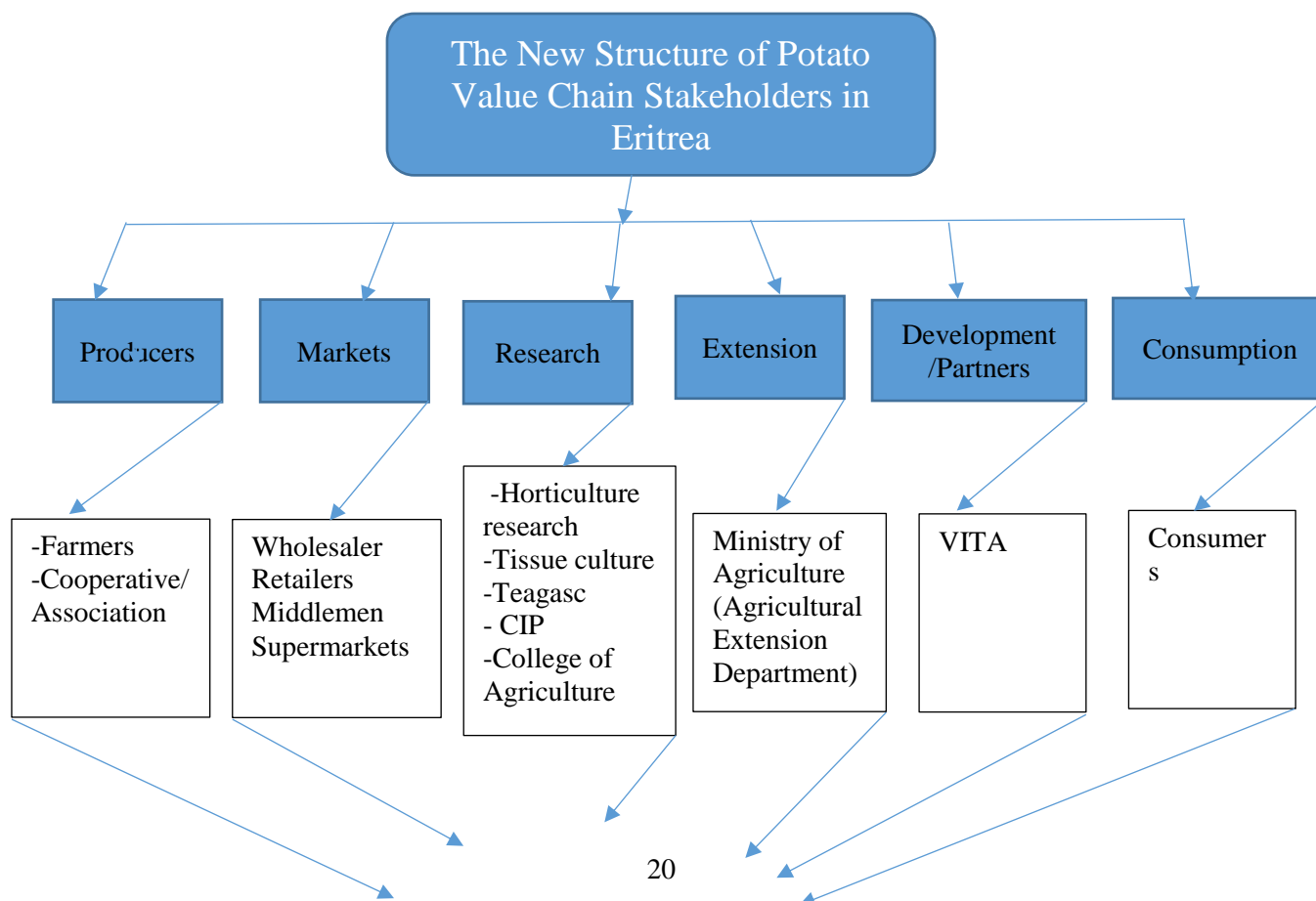
- Virus-free planting material will be developed at NARI.
- Appropriate cultural practice management practices will be adopted (irrigation scheduling and appropriate way of fertilizer application, appropriate plant population for seed production).
- Crop rotation protocols will be designed and provided to individual potato seed growers.

IV. Storage Improvement

At the end of the project at least 75% of the beneficiaries should own the simple diffuse light store. The dialogue on the issue of land ownership and land tenure system problem is going on. After resolved the farmers can built it easily. This is the second component after improved varieties usually requested by the farmers to be solved soon.

V. Potato market system:

As access to markets is a crucial factor in relation to land use in the highlands, marketing information will be provided to the target farmers, such as product quantity and quality requirements, prices, as well as where and how to sell their crops. The creation of farmers' groups will be supported to manage production and marketing activities, plus the project farmers will be trained on how to run such groups so that they can then manage the process by themselves. However, advice will continue to be provided where needed.



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14.0 References

Ali, A. M. (2004). Proceedings of Workshop on National Seed Potato Multiplication Pilot Project Proposal, Halhale (31/04-01/04/2004).

Ali, A. M. (2007). Terminal report on BADEA Technical Assistance to National Agricultural Research Institute, Halhale (August, 2005-july 2007).

Azieb, M., Freselam S., Sofia T. (2012). Survey on potential and constraints of potato production in Zoba Maekel. Department of horticulture, Hamelmalo Agricultural College, Eritrea.

BecA-ILRI Hub in Eritrea. (2015). Biosciences eastern and central Africa-International Livestock Research Institute Hub, Nairobi, Kenya.

Beukema, H.P and D.E.vanderZaag (1990). Introduction to potato production. Wageningen, the Netherlands.

Biniam, M.G., Githiri, S.M., Tadesse M. and Remmy W.K. (2014). Diagnostic Survey of potato production practices in Eritrea. *Journal of Agricultural and Biological Science*, Vol. 9, NO. 12, ISSN 1990. Asian Research Publishing Network.

Biniam, Tesfagabir. (2006). Estimating Potato Yield Loss from Normally Propagated Seed Tubers By Comparing Them With Heat Treated Micropropagated Plants. Msc thesis. University of Asmara. Asmara Eritrea.

Biniam Tesfagabir and Tadesse Mehari. (2008). A Survey of viral status on potatoes grown in Eritrea and *in vitro* virus elimination of local variety 'Tsaeda embaba'. *African Journal of Biotechnology*. Vol. 7 (4), pp. 397-403, Asmara, Eritrea.

Daniel Z.Z. and Biniam M.G (2016). Response of Potato Varieties to Potassium Levels in Hamelmalo Area, Eritrea. *Journal of Plant Studies*; Vol. 5, No. 1; 2016 ISSN 1927-0461 E-ISSN 1927-047X Published by Canadian Center of Science and Education.

FAO and CFC, (2011). International Year of the Potato. Rome.

Horticultural Research Report (2010). Annual Report. Halhale, Eritrea.

Horticultural Research Report (2011). Annual Report. Halhale, Eritrea.

Horticultural Research Report (2014). Annual Report. Halhale, Eritrea.

International Potato Center (2012). Wealth Creation through Integrated Development of the Potato Production and Marketing Sector in Kenya, Uganda, and Ethiopia. Nairobi, Kenya.

Lekgau, S and Jooste, A (2013). Potato Case Study of a successful Black farmer fuelled by Potato passion. Pretoria, South Africa.

Michael, C.J. (1989). Diffuse-Daylight: Seed Potato Tubers: Light and Sprout growth. Department of Chemistry (Agriculture), the University of Glasgow, Scotland, UK.

Murphy, H. F. (1968). A report on the Fertility status and other data on some soils of Ethiopia, Bulletin, College of Agriculture, Haile Sellasie I University, Experiment station, Dire Dawa, Ethiopia, No 44.

MOA. (2010). Horticulture Report. Asmara, Eritrea.

MOA. (2011). Annual Report. Asmara, Eritrea.

MOA. (2013). Planning office report. Asmara, Eritrea.

MoA. (2014). Planning office Report. Asmara, Eritrea.

Negassi A., Bein E., Ghebru K. and Tengnäs B. (2002). Soil and Water Conservation Manual for Eritrea. RELMA. Technical Hand-book No. 29. Nairobi, Kenya.

Tadesse, M. (2000). Manipulating the Physiological Quality of *in vitro* Plantlets and Their Transplants of Potato. PhD thesis, Wageningen University, The Netherlands.

Tuku, Bereke-Tsehay (2000). Potato Production in Eritrea: Prospects for Future Development. Proceedings of the Fifth Triennial Congress of African Potato Association. Kampala, Uganda.

Tewolde, A. and Ghebreyohanes F. (2003). Downstream Irrigation Development of Horticultural Crops on Selected Dams: Socio-economic baseline Survey. In: Mehari, T. and Ghebru, B. (Ed). Irrigation Development in Eritrea: Potentials and Constraints. Proceeding of the Workshop of the Association of Eritrean in Agricultural Sciences (AEAS) and the Sustainable Land Management program (SLM) Eritrea.

NFIS, (2005). Baseline Study on Livelihood System in Eritrea. Phase I: Preliminary Identification of livelihood Systems through Research on Secondary Sources (Draft). National Food Information Systems of Eritrea, Zoba Maekel, Eritrea.

Pervez, M. A., Ayyub, M. I. C.M., Shabeen, M. R., & Noor, M. A. (2013). Determination of Physiomorphological Characteristics of Potato Crop Regulated by Potassium Management. Pakistan Journal of Agricultural Sciences, 50(4), 611-615.

Villamayor ,FG (1984). Growth and Yield of potatoes (*Solanum tuberosum*) in the lowland of the Philippines. Ph.D Thesis. University Guelph.

VITA. (2013). Potato National Evaluation Report. Asmara, Eritrea.

VITA. (2015). Community led Potato Seed Production, Multiplication and distribution Report in Regions of Debub, Maekel and Anseba. Asmara, Eritrea.

Woldesslasie, O. and Brigitta, S. (2011). Sustainable Land Management. A text book of focus on Eritrea. Geographical Bernensia, Keren, Eritrea.