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Apple Orchards and Farmers Practices in Their Management in Mt. Elgon Subzone of Eastern Uganda

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Abstract
Apple (*Malus domestica* Borkh.) is one of the most popular fruits in world priced for its diverse uses, high dietary content and health benefits. Naturally adapted to cold conditions, apples require substantial hours of coldness or at least climatic conditions simulating cold conditions to be productive. In Uganda, apples were introduced in 2009 at experimental sites in western highlands of Kabale with scale up to Mt. Elgon region in the eastern part of the country in 2004. Since the introduction of apples in the Mt. Elgon zone, there has been no effort to document the performance in terms of growth, yield and even number of orchards, varieties as well as number of plants. A survey targeting all the apple orchards was conducted in June 2013 in eight districts of Mt. Elgon area to establish the status of apple growing and document the practices, challenges and opportunities for apple production in the zone. A total of 26 apple orchards comprising 1312 apple plants spread across 14 varieties were documented. Major orchard management practices included weeding, spraying and manure application. The main sources of planting material was from western Uganda although some farmers accessed materials from Kenya. Farmer's major constraints to apple growing included lack of technical knowledge, pest and diseases and limited access to clean planting materials. Opportunities such as cold condition on the highlands and available market for apples provide high potential for apple growing in the sub-zone. However, there is need to build the capacity of farmers and develop sustainable source of clean apple planting materials to increase adoption and enhance production of the apples in the zone.
Keywords: Apple, Orchard management, Farmer practices, Mt.Elgon, Uganda

1. Introduction

Apple (*Malus domestica* Borkh.) is one of the most popular fruits in world priced for its diverse uses, high dietary and health benefits (Dobrzañski *et al*. 2006; Janick 2005; Boyer & Liu 2004). Apples make for up to 50% of the world's deciduous fruit tree production and they are one of the most consumed fresh fruits in the world (Ntakayo *et al*. 2013). Naturally adapted to temperate climates, apples require substantive periods of hours under 7^0C otherwise referred to as cold or winter chilling of up to 1,400 hours to break dormancy, a factor that is limiting in the tropical climates (Dereje *et al.* 2010; Griesbach 2007). Studies have shown promising potential for apple production in limited cold conditions under 13^0C especially in high altitude areas of above 1800m above sea level (Griesbach 2007; Byarugaba *et al*. 2013; Ntakayo *et al*. 2013). However, this has to be combined with practical routines to bring the plants to dormancy such as reducing soil moisture and hand or chemical defoliation of the plants to induce dormancy, trigger flowering and then encourage fruiting (Getachew *et al*. 2011; Dereje *et al.* 2010)

In Uganda, apples were introduce in 1999 by the National Agricultural Organisation (NARO) in the western highlands of Kabale with a purpose of identifying adaptable apple varieties (Chemining'wa *et al*. 2005). In 2000, apple growing was established in the highlands of Kabale (Byarugaba *et al*. 2013) and extended to eastern highland of Mt. Elgon in 2004 by World Agroforestry Centre ICRAF and National Forestry Resources Research Institute (NaFORRI) a subsidiary of NARO with introduction of six cultivars namely; *Anna, Golden Dorsett, Badskoop, Jonathan, Winter Banana* and *Gloster* at Buginyanya Zonal Agricultural Research and Development Institute. Along with the experiment established at Buginyanya stations, demonstration mother gardens were established by local district authorities as possible source of scions and rootstocks. Some farmers, with support of government and other development partners quickly adopted this intervention and some apples were planted. The performance of these have not been studied thus paucity in knowledge of their performance and the practices employed by farmers in their management. Performance of apple cultivars vary from place to place (Janick *et al*. 1996) and in tropics, specific management practices are required to enable apples grow and bear fruits (Chemining'wa *et al*. 2005). The purpose of this study was to identify the existing apple orchards and apple cultivars in cultivation, document the major management practices, existing challenges and opportunities for commercial apple growing in the study area. It was envisioned that the information generated would strengthen temperate fruits research and specifically apple growing in the south eastern agro-ecological zone under the mandate of Buginyanya Zonal Agricultural Research and Development Institute (BugiZARDI).

2. Materials and methods

2.1 Description of study area

This study was conducted in eight districts Mt. Elgon subzone namely; Bududa, Bukwo, Bulambuli, Kapchorwa, Kween, Manafwa, Mbale and Sironko. Mt. Elgon subzone is located in eastern Uganda surrounding the Mt. Elgon National Park (MENP). MENP, located between 1^0 25'N and 34^0 30'E is transboundary ecosystem jointly shared by Uganda and Kenya from the east and west respectively and is approximately 100km north-east of lake Victoria (Buyinza *et al*. 2007). The slopes of Mt. Elgon are characterised by high, well distributed bimodal rainfall pattern averaging 1200mm/year (Barungi *et al*. 2013); high altitudes ranging from 700m to 2800m on farm land rising to 4320m above sea level at the peak of the mountain (Barungi *et al*. 2013; Buyinza *et al*. 2007). The area experiences cool sub-tropical temperatures with minimum and maximum averages of 15^0C and 28^0C respectively (Bamutaze *et al*. 2010) this temperature range is particularly favored for apple growing with other temperate fruit varieties. The area enjoys fertile soils of the volcanic origin suitable for arable farming in which arabica coffee production thrives in Uganda (Bamutaze *et al*. 2010; Buyinza *et al*. 2007).

2.2 Study design, data collection and analysis

A household survey involving apple orchard owners in eight districts of Mt. Elgon subzone. The study was designed to cover all the apple orchards that could be located in the zone to generate as much information as possible on the orchards. All farmers that had apple (s) were considered regardless of the number and size of the apple plants. Farmers were located with the help of district production officers and local extension workers. Fellow apple farmers also helped in locating some of their colleagues involved in apple growing in area simulating a snow-ball approach (. Data were collected using a pre-designed questionnaire administered by a subject matter specialists comprising scientists and technicians Buginyanya Zonal Agricultural Research and Development Institute (BugiZARDI). The questionnaire was designed to capture information on socioeconomic characteristics of the farmer, the details of the orchard including the number of plants, the varieties, source of planting materials, the status of the plant in terms of fruiting and management practices as well as challenges and farmer perceived opportunities for apple growing in the zone. Information on variety of apples was obtained from the farm records and orchard maps. Collected data was collated and cleaned for consistency and missing values. The data was entered into MS Excel spreadsheet and summarized into tables and charts.

3. Results

3.1. Apple orchards and varieties

Twenty six apple orchards and 1312 apple plants were documented in the eight districts (Table 1). Mbale had the highest number of orchards (6) while Sironko (1) and Manafwa (1) had the lowest number of orchards. Bulambuli (430) had the highest number total apple plants in a district followed by Kapchorwa (313) and Bududa (273) with Manafwa having the lowest number of plants.

Table 1. Distribution of apple orchards in the districts of Mt. Elgon zone

District	No. of orchards	Number of plants
Mbale	6	183
Bulambuli	4	430
Kapchorwa	4	313
Kween	4	63
Bududa	3	273
Bukwo	3	26
Sironko	1	16
Manafwa	1	8
Total	**26**	**1312**

About 35% of the apple orchards were established as mother gardens to evaluate performance of apple varieties in the zone and also to develop sources for planting materials especially scions for grafting. Fourteen (14) apple varieties were recorded in the study. Anna, Golden delicious, Golden Dorset and Winter Banana had the highest number of plants. (Fig.1).

3.2 Source of planting material

Most of the seedlings were provided to the farmers by development agencies most of which obtained the seedlings from the government research station Kachwekano Zonal Agricultural research and Development Institute in the western agro-ecological zone of Uganda. These include World Agroforestry Centre (ICRAF) with 11.5%, International Union of Conservation of Nature (IUCN) 15.4%, Mount Elgon Regional Ecosystem Conservation Project (MERECEP) 11.5%, National Agricultural Advisory Services (NAADS) 15.4% and Plan for Modernisation of Agriculture (PMA) 19.2%. Other sources of seed included Kabale district mainly from private nursery operators (3.8%), from private nursery operators from neighbouring Kenya (19.2%) and seedling

apples which were germinated from seeds extracted from an apple plant purchased from the market in Mbale. Overall, overall, 77% of the planting materials were obtained from Kabale with 72.2% coming from the research station and the 3.8% coming from the private nursery operators.

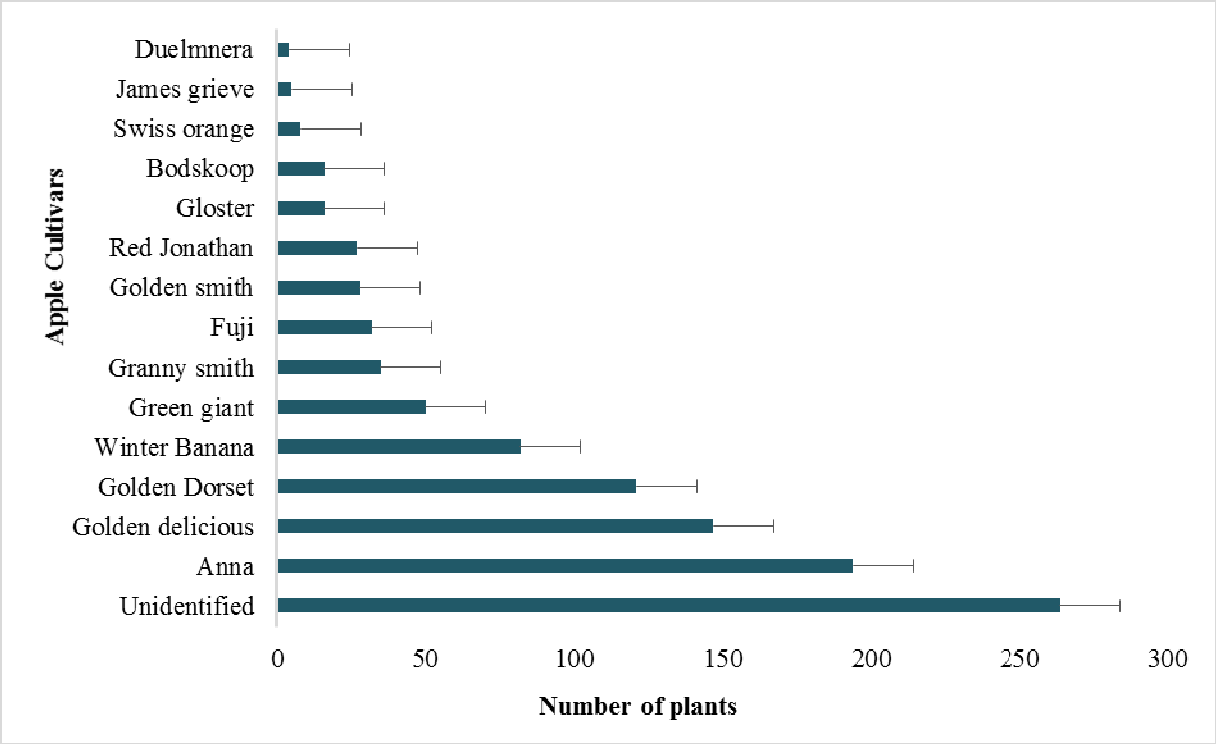

Figure 1. Apple varieties in Mt. Elgon zone

3.3 Reason for planting apples

Income generation was the most important reason for planting apples (83%). Others reasons included food (73%), demonstration as mother garden, taking advantage of the good climatic condition, availability of seedlings as well as just as flowers to decorate their compounds (Figure 2)

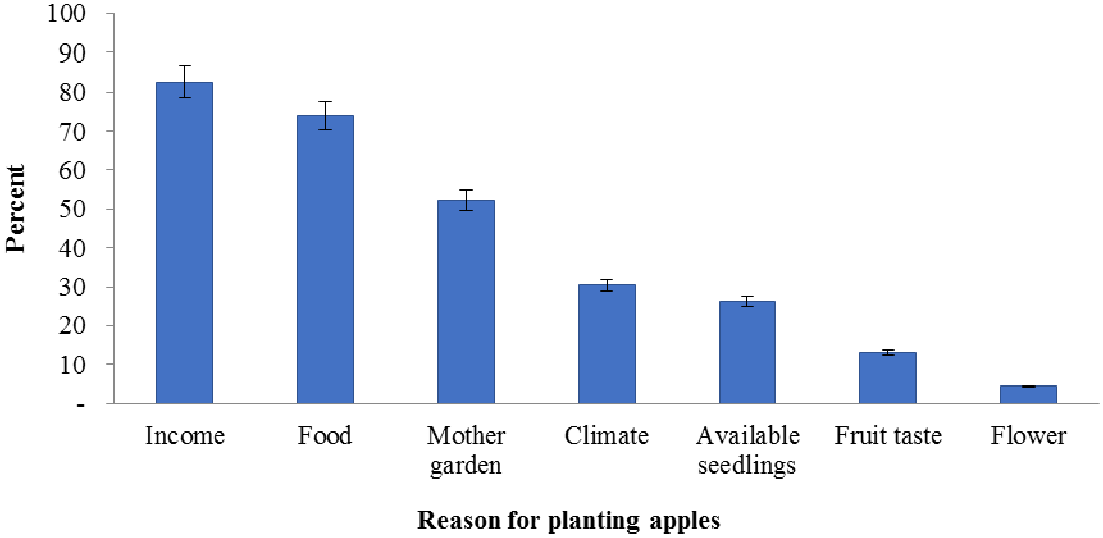

Figure 2. Reasons for planting apples as given by farmers

3.4 Orchard management practices in the zone

The major orchard management practices documented included fertiliser application using largely NPK, CAN and DAP. Manure was the most prevalent form of fertilisation used. All the farmers used some form of organic manure in the orchards either as standalone treatment for improving fertility in the orchards for the apple plants or as blanket application for crops grown in the apple orchards. All the apple orchards were intercropped. The

major crops in the intercrop were beans, coffee, banana, carrots, maize and potato. Other management practices recorded include watering especially for young plants below one years old and in dry season, weeding, mulching, defoliation, pruning, spraying for pests and diseases.

Table2 Management Practices in Farmers Orchards in Mt. Elgon zone

Practices	Frequency (n=26)	Percent
Fertilizer application	15	58
Watering	14	54
Weeding	11	42
Defoliation	7	27
Mulching	5	19
Spraying	5	19
Pruning	3	12
Training branches	2	8

3.5 Major challenges and opportunities for apple growing in the zone

Farmers enumerated a number of challenges faced in apple growing. Key amongst these challenges included lack of technical knowledge about apples and their management, pests such as aphids, leaf miners and birds, diseases which included apple scab, powdery mildew and drying of apple plants due to drought and unknown root or soil borne diseases. Limited access to quality planting materials, expensive inputs and also knowledge of right input combinations for proper apple production were some of the limitations mentioned in the study (table 3). However, beyond the challenges, farmers expressed optimism and willingness to continue with apple growing since the enterprise looked promising. Major opportunities mentioned by the farmers included the good climatic condition, lack of tropical fruits in the zone giving and edge to apples as a high value crop, limited land resources which can only enable investments in high value crops and willingness of development partners to promote apple growing in the zone.

Table 3. Challenges faced by apple farmers in the zone

Challenges	Frequency	Percent
Lack of knowledge on orchard management	26	100
Theft fruits and seedlings	12	46
Destruction by domestic animals	10	38
Fruits destroyed and eaten by birds	9	35
Lack of planting materials	9	35
Plant death and fruit abortion	8	31
No follow-up by suppliers/extension	3	12
Damage by insects	3	12

4. Discussion

This study identified the existing apple orchards in the zone locating 26 apples and documenting 1312 apple plants in different growth stages. Although fourteen apple varieties were documented, many of the apple plants could not be identified to variety level. This was basically because farmers did not have the records to trace the varieties. Besides, there is still limited expertise in the country to enable proper identification of the apple plants (Chemining'wa *et al*. 2005). More than half of the total plants reported were not identified to variety. This mainly as a result of the cross border exchange of materials between farmers from Uganda and Kenya in which case there is no record and no adherence to the standard guidelines for seed and planting material imports (Sebuliba 2010). The action of the farmers to source the materials from unverified sources is a clear sign of demand for the planting materials. A similar trend of cross-border access of planting is reported for maize in eastern Uganda in (Kagoda *et al*. 2016).

Thirteen of the apple varieties recorded in this study have been recorded elsewhere in the country (Turyomurugyendo *et al*. 2004). Most of these varieties are among the top commercial apple varieties in the world (Anon n.d.). Apple varieties Golden Dorset (GD) and Anna have been released for production in Uganda following successful adaptive trials in highlands Kabale (Byarugaba *et al*. 2013). The same varieties (Anna and GD) were the most abundant in the Mt. Elgon sub-zone probably due the fact that they are the most adapted in the country and could also be because over 60% of the planting material for apples in zone were obtained from Kabale. Nevertheless, though in small numbers, eleven other varieties were encountered in the survey. This shows potential for more varieties of apples in the zone other than the six evaluated at the research station. There are over 1000 apple varieties in commercial production in the world and many have been successful in tropical climates (Hauser 2013). Some of these unidentified varieties have fruited and thus have potential for expansion of apple varieties beyond the two varieties currently released and recommended for commercial production in the country (Byarugaba *et al*. 2013)

Apples are demanding plants with specific management demands to be viable and productive (Hauser 2013). For instance in their natural environment, apples need very low temperature of between 2^0C to 9^0C to undergo dormancy (otherwise known as chilling) and requires cumulative time of between 800-1000 hours in the cold temperature range to be productive (Hauser 2013). In tropical region where low temperature may not offer sufficient "chill" to induce dormancy and trigger processes like new growth and flowering, a mechanical approach is required. These practices include hand defoliation, pruning and training of branches to below or near horizontal. These activities are associated with enhancing plants health and production potential through hormonal triggers and physical improvements in structure and spaces available for plant growth and development including flowering and fruiting (William 2010; Ferree & Schupp 2003; Marini 2009). Once these three processes (defoliation, pruning and training) are missed, the plant will remain vegetative with little or no fruiting at all. It was therefore not surprising that most of the trees in the various orchards had over grown with little or no production. This was clear sign of lack of knowledge by farmers on management demands and practices in apple orchards. Many of the farmers managed the apples as they would manage other tropical fruit trees which should not have been the case if they were guided on proper apple orchard management practices.

Opportunities for apple production included high interest and enthusiasm of farmers to adopt new technologies. The cold temperatures experienced in the zone and limited potential for growing of tropical fruits in the zone. Available markets for fresh apple fruits and growing fruit industries offer a great opportunity for apples industry in the zone. Perennial crop and potential to contribute to stabilisation of soils, reduction of soil erosion, will of the local authorities to support the project – Bukwo, Kween and Kapchorwa are keen on promoting apple production in the zone. Similar opportunities have been recorded elsewhere in the country (Chemining'wa *et al*. 2005)

5. Conclusion

This study sought to generate information of existing apple orchards and their management practices as well as challenges and opportunities prevailing. The information generated by this study provides a baseline for temperate fruits project which will be valuable in further research work on apples in the Mt. Elgon zone. Based on the findings, Mt. Elgon is a potential area for apple growing which is manifested by the fruiting of some apple varieties even with minimum management. Good agronomic practices could help improve on the production levels and could present apple growing as an alternative high value enterprise and source of income for small holder farmers of Mt. Elgon region. However, for all this to be effective, there is need for more research on performance of individual varieties already existing and also introducing new ones and evaluating them for adaptability to expand on the varieties available for uptake. The need to establish a sustainable source of planting materials is glaring and technologies such as grafting and tissue culture options could be explored. More information needs to be generated in pests and diseases of apples and how they can be managed including options of developing pests and disease tolerant varieties.

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