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Local knowledge of pumpkin production, performance and utilization systems for value addition avenues from selected agro-ecological zones of Uganda

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Pumpkin is one of the underutilized fruit vegetables in Uganda despite the fact that it has wide spectrum of both nutritional and medicinal values. A survey was carried out to document local knowledge of pumpkin production; performance and utilization systems to aid the selection of pumpkin varieties to be used for particular value addition avenues. It was observed that twelve varieties of pumpkin are commonly grown and they are mainly distinguished by their skin colour, texture of epicarp and shape. Pumpkin production levels on large scale, small scale and subsistence were at 27.8, 66.7 and 5.6% respectively. Farmers reported that 'pumpkin seeds are usually sown directly into the main garden;' thus, nursery beds are rarely used by the farmers. Farmers appreciate the crop's nutritional and medicinal values, in addition to being a source of livelihood. Pumpkin fruit vegetable is multi-purpose in that all the parts of the plant can be consumed thus minimizing food wastage and also the plant can stay long on the shelf thus has the potential to act as a food security crop. From the survey, it was observed that mostly elderly people above 46 years were involved in pumpkin cultivation; youths were less involved and pumpkin cultivation is mainly practiced on a small scale. The youths need to be educated and encouraged to get involved in pumpkin cultivation since it can reduce poverty levels, food insecurity and malnutrition.

Key words: Agro-ecological zone, local knowledge, medicinal value, nutritional value, pumpkin, variety.

INTRODUCTION

Cucurbita species are indigenous to America. The cultivated species are now widely disseminated throughout tropical, subtropical and temperate regions of the world (Whitaker and Bemis, 1975), including Africa where they have become naturalized and are categorized among indigenous vegetables (Abukutsa-Onyango, 2007). Pumpkins can grow well in almost all African countries and these include, Nigeria, Zimbabwe, Malawi, Zambia, Uganda, South Africa, Kenya (Ngwerume and Grubben, 2004). For Uganda in particular, the districts that grow pumpkins include Kabale, Jinja, Mbale, Mityana, Mubende, Luwero, Nakaseke, Kabarole, Arua among others. There are quite many species of pumpkin in the world and these include *Cucurbita pepo, Cucurbita maxima, Cucurbita moschata, Cucurbita mixta* and *Cucurbita facifola* (Whitaker and Bemis, 1975). *C.*

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moschata, C. pepo, C. maxima are the mostly commonly domesticated species of pumpkin worldwide (Martins et al*.,* 2015). Pumpkin has a position of high value among the Cucurbitaceous vegetables, due to its long shelf life, long period of availability, high nutritive estimates, medicinal properties, and better transport qualities. It is used at both mature and immature stages as a vegetable. It is also consumed after processing (Ravani and Joshi, 2014).

Conservation of plant genetic resources in East African countries has greatly given priority to cultivated mainstream food crops and less emphasis has been put on the underutilized crops like pumpkins (Hamisy et al., 2002). As a result, there has been over reliance on a few staple food crops like maize and cassava and to a lesser extent millet, sorghum, potatoes and bananas which lack most of the nutrients required for human health contributing highly to malnutrition. Consequently, traditional crops such as pumpkins, which are endowed with nutrients, are so far not highly considered by the smallholder farmers in the region (Ondigi et al., 2008). Furthermore, the pumpkin landraces in Uganda are known by vernacular names such as Nsujju (Luganda), Ebyozi and Ebihaza (Rukiga and Runyakole) which hinders easy the identification of pumpkin landraces with good characteristics due to language barrier since Uganda has a wide diversity of languages (UBOS, 2014).

With time, if no effort is made to document the knowledge on pumpkin production, utilization and conservation there would be knowledge erosion especially on the local pumpkin varieties grown in Uganda. In addition, farmers will not be able to identify the best varieties to grow for commercial purposes in order to consequently meet the quality standard for different value addition avenues and also to know the most yielding variety. Therefore, the main objective of this study is to evaluate and document local knowledge on pumpkin production systems, utilization and conservation status in four agro-ecological zones of Uganda.

METHODOLOGY

Study site

The study was conducted in in six districts from five agro-ecological zones of Uganda. These were Southwestern highlands (Kabale and Kanungu districts), Western mid-altitude farmlands and Semiliki flats (Masindi and Mubende districts), Western medium-high farmlands (Kabarole district) and Lake Victoria and Mbale farmlands (Mityana district) as represented in Figure 1. Villages namely, Mwangyale and Nyakibande in Kabale, Rugyeyo in Kanungu, Kihubba and Bugyenje in Masindi, Butologo in Mubende, Nyamiseke in Kabarole, Nkokonjeru and Kalangalo in Mityana were visited.

Sampling and data collection

Non-probability methods that is to say, purposive sampling coupled with snowball were applied to recruit participants for the study (Acharya et al., 2013). A total of 36 pumpkin farmers were involved. Cross sectional surveys, focus group discussions, rapid participatory observation appraisals, and face to face interviews were used to gather information on knowledge about pumpkin production, performance and utilization systems in four agro-ecological zones of Uganda. A questionnaire consisting of structured and semi-structured items in line with pumpkin growing, performance and utilization was designed to guide the interviews. Photographs of the pumpkin landraces grown were taken using a digital camera (Johnson and Turner, 2003).

Data analysis

The qualitative data obtained from the narrative interviews and participatory observation appraisals were coded and entered into IBM Statistical Package for Social Scientists (SPSS) software 20.0 (2011). The data were analyzed to generate numerical interpretation and percentages of the multiple responses obtained about local knowledge on production and utilization systems of pumpkin landraces in Uganda. Data were presented in form of tables and graphs using Microsoft excel professional plus 2016 version. General information that was common for almost all the farmers was not coded but rather qualitatively analyzed and presented as a narrative following the guidelines by Bogdan and Biklen (2007).

RESULTS

The information on local knowledge of pumpkin farmers on pumpkin production, performance and utilization systems is reported as follows:

Pumpkin production system in Uganda

Socio-economic information of pumpkin farmers

As indicated in Table 1, the male respondents (52.8%) were slightly more than the female respondents (47.2%). A considerable number of the farmers interviewed were educated at least up to primary level (61.1 %) and the majority of the farmers were above 46 years of age (50.0%) which shows that the youth are less involved in pumpkin cultivation. Additionally, most of the respondents practiced pumpkin growing on a small scale (66.7%) or intercropped (63.9%) with other crops such as sorghum, banana, beans and maize. Some of the farmers grew pumpkins alone on a large scale (27.8%).

Reasons for cultivating pumpkin crop

Farmers' responses indicated that pumpkins in the past were mainly grown for domestic consumption though of recent they are being grown as a source of income to earn a living. From the analysis, the major reason for cultivating pumpkin was food security (46.2%), the second reason for growing pumpkin was income generation (43.6%), then the fact that the crop is easy to cultivate (5.1%) and can be used as an animal feed

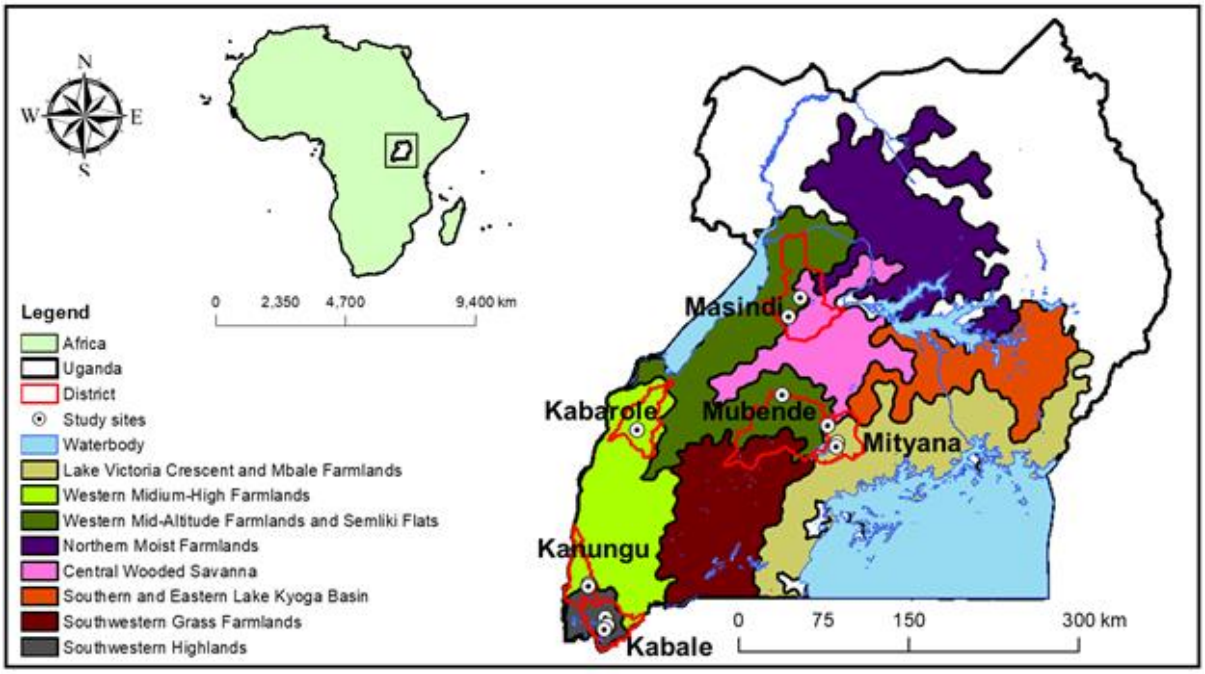

Figure 1. Map showing sites from which data was collected,
Source: Drawn using Quantum Geographical Information System software, version 2.18.1

Table 1. Socio-economic informtation of pumpkin farmers (n=36).

Demorgraphic	Category	Percentage
Sex of farmer	Male	52.8
	Female	47.2
Education level	Primary	61.1
	Secondary	27.8
	Tertiary	11.1
Type of farming	Large scale farmer	27.8
	Small scale farmer	66.7
	Subsistence farmer	5.6
Farming practices	Monocropping	36.1
	Intercropping	63.9
Age of respondent	18-25	5.6
	26-35	22.2
	36-45	22.2
	46 and above	50.0

(5.1%) for example, for pigs.

Pumpkin cultivation practices

The pumpkin seeds were mainly obtained from some of the mature harvested pumpkin fruits, some farmers reported that they buy the seeds from known pumpkin farmers who have knowledge about the most preferred pumpkin varieties. Some farmers obtained seeds from friends who had previously planted delicious pumpkin varieties. The farmers also reported that the pumpkin

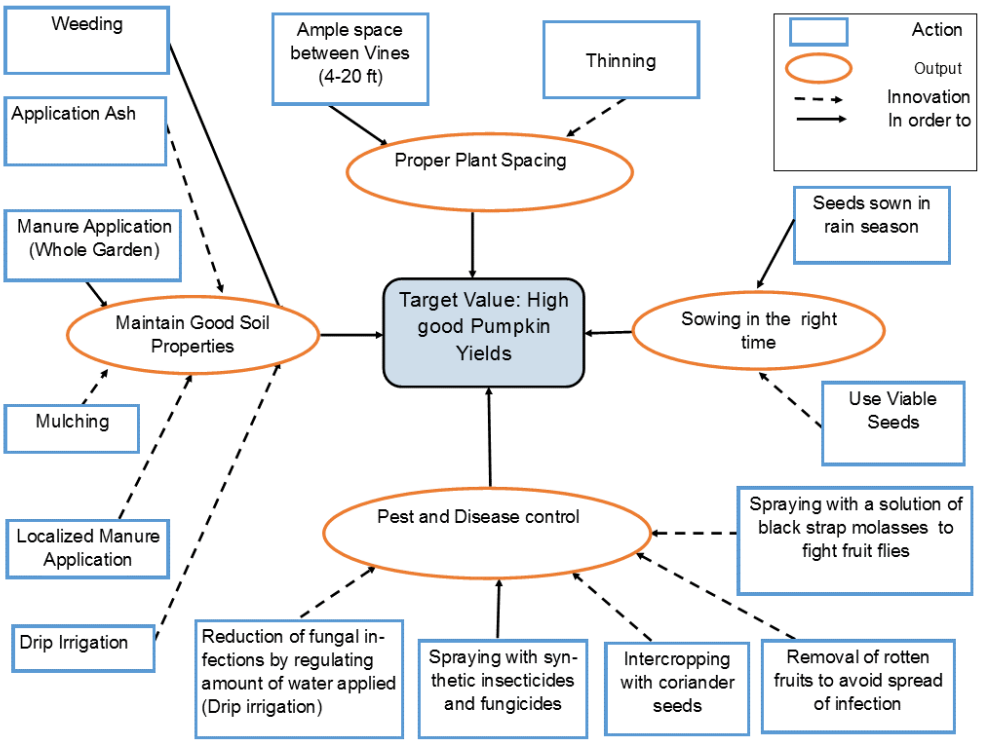

Figure 2. Simplified representation of routine control rules to i) ensure proper plant spacing, ii) sow seeds in the right time, iii) maintain of good soil properties and iv) control pest and disease, Source: Adapted and modified control loop model from Restrepo et al. (2016).

seeds are usually sown directly into the main garden, thus nursery beds are rarely used especially by small scale and subsistence farmers. Some pumpkin farmers who grow pumpkins on a large scale sometimes plant some pumpkin seeds in a nursery bed which are later transplanted to the main garden to fill up the gaps where seeds did not germinate after direct sowing. Usually decomposing animal wastes such as goat dung, cow dung, or chicken droppings are used as manure, which is first mixed with soil dug from a hole 30 cm deep and 30 cm wide. Thereafter, about 2-5 pumpkin seeds are planted in the hole where manure was applied at 3-5 cm depth. While digging the holes where seeds are to be planted, ample spacing should be emphasised since it contributes to good and high pumpkin yields. Spacing of about 4-20 feet is normally used depending on size of someone's land. On average, one hole can be 10 feet away from the other to provide adequate space for the pumpkin vines to creep so as to produce a reasonable number of fruits. Sowing is mainly done during the rainy season, that is to say, from mid-February to early June for the first season, and from September to December for the second season. The first season usually has short rainfalls so the yields are not as high as those of the second wet season that normally has relatively prolonged rainfalls. Furthermore, some farmers irrigate their crops during the dry season to ensure continuous pumpkin production and supply to markets. The pumpkin seeds take about 7-14 days to germinate depending on the variety sown and prevailing environmental conditions. Farmers also reported that the pumpkins take 3-12 months from the time of sowing to mature. The maturation time depends on the geographical location (environment) for instance, nature of soil, rainfall received, temperature and also the variety grown. Pumpkin farmers carry out some routine actions that they believe directly contribute to the final output of good high pumpkin yields. The routine activities carried out by pumpkin farmers were grouped as i) proper plant spacing, ii) sowing seeds in the right time, iii) maintenance of good soil properties and iv) pest and disease control. Farmers carry out particular actions in order to achieve the sub-goals which in turn enable them to achieve the target value as indicated in Figure 2.

Almost all the interviewed participants reported that they applied manure before sowing the pumpkin seeds (27.0%). Most of the farmers weeded their gardens to remove unwanted plants (21.3%). A reasonable number of farmers reported that they mulched their gardens (15.6%). Some farmers reported that they spray insecticides to kill the pests such as fruit flies that would lead to heavy economic losses (10.7%). The other practices carried out by farmers to ensure good yield are good spacing (2.5%), removing rotten fruits (9.0%),

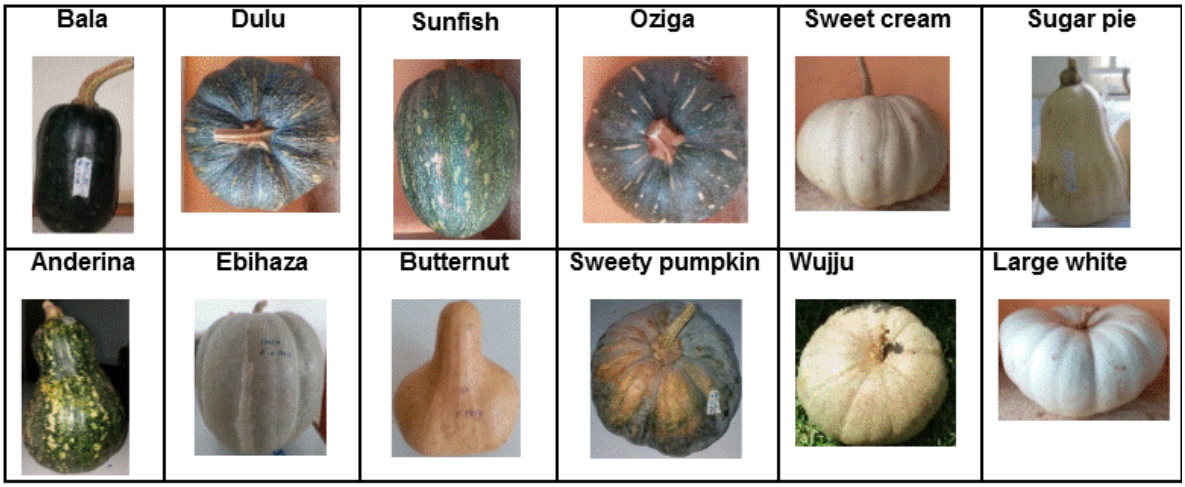

Figure 3. Pumpkin varieties commonly grown in Uganda.
Source: Nakazibwe (2017).

applying ash (0.8%), application of coriander seeds in the hole before sowing (1.6%), application of inorganic fertilizers such as leaf and flower boosters among others (4.9%), thinning (4.1%) and using good seed (2.5%) as shown in Figure 2.

Pumpkin varieties grown

Results from the interviews show that there is a wide range of pumpkin varieties grown in Uganda. These were summarized into twelve categories as revealed in Figure 3. The most cultivated pumpkin variety was Oziga (Luganda) (24.0%), followed by Dulu (Luganda) (22.6%), then Ebihaza (Rukiga/ Runyankole) (15.1%), Sweet cream (12.3%), Bala (Luganda) (11.0%), Butternut (4.1%), Wujju (Luganda) (2.7%), Anderina (Luganda) and Large white pumpkin (2.1%) respectively. The least cultivated variety was Sugar pie and Sweety pumpkin (0.7%) respectively.

Oziga was described as a medium sized pumpkin, with a globular shape; has secondary skin colour; is green with cream patches and soft fruit epicarp. Bala has a dark green skin colour without any patches. Its shape can vary from flattened to oblong and the fruit epicarp can be soft or hard. Dulu has a green primary skin colour with cream patches but with a hard fruit epicarp hence usually stays longer on shelf. Sunfish has a green primary skin colour with yellowish mottles, usually a soft fruit epicarp. The shape can be globular or oblong. Sweet cream has a cream fruit skin colour with no mottles and the shape is usually cylindrical or round. The fruit epicarp is frequently soft. Sugar pie has a cream fruit skin colour with no mottles, the shape is mainly pyriform and the fruit epicarp is frequently soft. Anderina has a green primary fruit skin colour with cream mottles, pyriform or dumbbell shape and the fruit epicarp is usually soft. Ebihaza has a gray primary skin colour with stripes and no mottles; the shape can be oblong or globular and the fruit epicarp can be hard or soft. Butternut has a tan skin colour without mottles; the shape is pyriform and with frequently a soft fruit epicarp. Sweety pumpkin has a dark green skin colour without mottles while immature and tends to orange when mature. It has a flattened fruit shape and the fruit epicarp is often soft. Large white has a white skin colour, flattened fruit shape and a soft fruit epicarp. Wujju has a gray primary skin colour with stripes between the ridges, the shape is mainly globular and the fruit epicarp is often soft.

Socio-cultural values associated to pumpkin cultivation

Some farmers reported that there are some socio-cultural values associated with pumpkin farming specifically; i) liquid from the node on the vine can treat red eyes. ii) Women in their menstruation periods should not go to the pumpkin garden since all the fruits in the garden may rot. iii) It is not good to point at the young fruits because they may rot. (iv) If one touches the young fruit, it rots. v) If one adds grasshopper wings to their garden, the vine would produce more fruits. (vi) If one throws rat dung to the garden, more fruits would be obtained. vii) On the other hand, many farmers did not attach any socio-cultural values to pumpkin cultivation. viii) If one fell sick and yet they have pumpkin flowers in the garden, they would not die but rather recover from the sickness.

Pumpkin maturity indicators

Farmers reported that there are certain parameters that are commonly observed to determine maturity of the

pumpkins namely; (i) the fruit epicarp hardens and its colour becomes very pale. (ii) Fruit stalk changes from dark green to a lighter colour for example, yellowish in some varieties while light green in others. (iii) The remains of the flower completely fall off from the fruit. (iv) Leaves dry and fall off from the vine. (v) The stem colour changes from dark green to brownish, fruit stalk dries and hardens (vi) For 'Kihaza,' fruit stalk develops cracks, and when hit with one's fore finger, the fruit produces a high pitch sound.

Pumpkin post-harvest handling to prolong shelf life

During harvest, since the pumpkins on one vine usually do not mature at the same time, the person harvesting should put the following precautions into consideration to minimize damage to both the vine and the harvested fruit so as to prolong the shelf life of the fruit. This is to also ensure that the fruit retains its appealing characteristics to the buyer/consumer. The precautions include; (i) proper breakage of fruit from the vine without damaging the vine, for example, by using a knife. (ii) Avoid stepping on the vines while harvesting to ensure that the remaining fruits on the vine grow up to maturity. (iii) Keeping the stalk intact to avoid microbial attack through careful handling and good transportation. (iv) Do not expose fruits to sunshine which catalyzes fruit quality deterioration thus, store them in a cool place. v) Avoid harvesting pumpkins when they are too mature since this reduces the fruit's shelf life in storage. (vi) While in storage, it is not good to pile fruits on one another this may cause rotting of some fruits especially those with a soft epicarp due to the pressure exerted on the lower fruit. vii) Providing good aeration in the store to prolong the shelf life of the fruits. viii) Using wooden stalls overlaid with dry grass or spread dry banana for storage of pumpkins to regulate temperature thus, minimizing rapid fruit deterioration. ix) Avoiding storage of pumpkins on bear ground in the store, this tends to compromise the shelf life of the pumpkins.

Pumpkin spoilage indicators

Farmers also reported that the pumpkin fruit can stay for a long period of time on the shelf (1-8 months) especially for the fruits with hard epicarps. In case the pumpkin loses its fruit stalk during carriage, it may not stay for long in storage, thus it easily deteriorates. While in storage, the following indicators can be used to tell if the pumpkin has gone bad: (i) loss of fruit stalk, the fruit stalk easily gets detached from the fruit, (ii) when the fruit is shaken, it sounds as though it has a liquid in it, (iii) the fruit skin texture becomes soft and appears as though it has got wrinkles, (iv) finger nail easily penetrates when pressed and the fruit has a bad smell, (v) the fruit becomes very pale, (vi) fluid oozes out of the fruit, (vii) a pumpkin with deep scars is susceptible to microbial attack and viii) the fruit slightly loses weight.

Performance and conservation status of pumpkin (*Cucurbita spp*)

Pumpkin commercial production in Uganda is still on a very small scale as specified in Table 1 above. Additionally, some farmers believe that pumpkin production is gradually increasing as awareness about the benefits of pumpkin consumption is being emphasized among different communities to deal with malnutrition, food insecurity and poverty. Although the pumpkin fruit vegetable has nutritional and medicinal values, from the survey, no National Agricultural Research Institute has supported the farmers to address the challenges faced by pumpkin farmers since pumpkin is not one of the main stream crops grown in Uganda. Farmers testified that about 3-50 fruits can be harvested from a pumpkin vine in a given season; nevertheless the harvest depends on variety cultivated and soil quality. Some farmers reported that it is not easy to keep track of the number of harvested fruits per vine since the vines intertwine in the garden. Fruits harvested also depend on the prevailing environmental conditions such as rainfall received. Some farmers observed that big sized fruits lead to production of fewer fruits per vine (about 8 fruits) while the small sized fruits lead to production of more fruits per vine (15-20 fruits).

Source of market and mode of transportation of pumpkin produce

From the interviews, farmers reported that the major source of market for the pumpkins grown were vendors (47.7%), who in turn sold the pumpkins to different markets both local and across borders such as Rwanda and Southern Sudan. The second source of market for pumpkins were the neighbours of the farmers (46.2%), who do not grow pumpkins but are interested in consuming pumpkin. The least source of market was the hotels and events such as parties (weddings) (6.2%). The mode of transportation of the mature pumpkins from the garden to the respective markets ranged from vehicles (59.1%), followed by motor cycle (34.1%), then motorcycle (4.5%) and very few farmers transported pumpkins to markets on foot (2.3%) especially for the farmers whose market sources were near where they cultivate from.

Challenges faced by farmers during pumpkin cultivation

The farmers reported that there are a number of challenges associated with pumpkin cultivation namely;

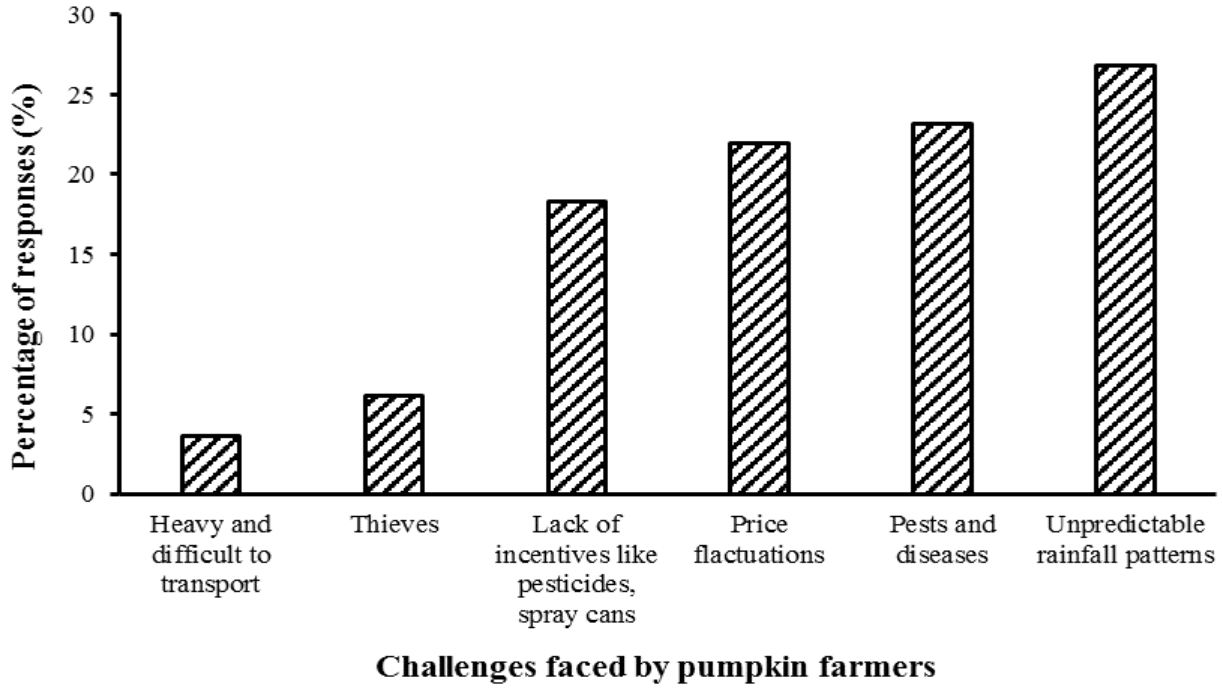

Figure 4. Major challenges faced by pumpkin farmers.

unpredictable rainfall patterns (26.8%), pests and diseases (23.2%), price flactuations (22.0%), lack of incentives like pesticides (18.3%), thieves (6.1 %), and the pumpkin heads are heavy and difficult to transport (3.7%) as shown in Figure 4.

Utilization of pumpkin in Uganda

Pumpkin parts consumed

The most consumed part of the pumpkin was the pulp (32.1%), followed by the seeds (31.3%), then the leaves (26.8%), and the least consumed part was the flowers (9.8%). Farmers reported that the most preferred pumpkin varieties were Oziga (Luganda), Sweet cream, Bala and Dulu. There are quite a number of value addition avenues associated to pumpkin consumption as a way of minimizing post-harvest losses especially during the periods of high production, and demand fluctuation. The pumpkin value avenues are discussed in Table 2.

Modes of preparation of pumpkin for consumption:

There are different modes of preparing the different pumpkin parts for consumption namely, boiling pulp alone (10.5%), steaming the pulp (16.0%), boiling pulp with already cooked beans (5.5%), roasting the pulp in a local oven (1.7%), steaming the leaves as vegetables (8.3%), cooking the leaves with other sauce like beans (15.5%), roasting the seeds (19.3%), cooking seed flour as sauce (8.8%), cooking young fruits/flowers with leaves as vegetables (5.5 %), cooking young fruits/flowers with other sauce such as ground nuts (8.8%). These are also highlighted in Table 2 with their respective value addition avenues.

Medicinal values associated to pumpkins

Farmers reported that there are quite number of medicinal values associated with pumpkin consumption, such as boosting immune system (40.0%), improving someone's eye sight (11.1%), improving erectile functionality in men (8.9%), unblocking sperm ducts in men (7.8%), treating abdominal disorders (6.7%), good memory (6.7%), relieving diabetes (6.7%), strengthening bones (4.4%), improving muscle activity (2.2%), treating epilepsy (2.2%), preventing some cancers (2.2%) and curing allergies (1.1%) as described in Table 2.

DISCUSSION

Socio-economic informtation of pumpkin farmers

The male respondents were more than women especially in commercial pumpkin production because usually, men are the heads of the family and this is in line with the

Table 2. Pumpkin modes of utilization and possible value addition avenue.

Mode of utilization	Pumpkin part consumed	Method of preparation for consumption	Pumpkin value addition avenue	Basis for value addition
Food	Pulp	(i) Boiling pulp alone (ii) Steaming the pulp	Pumpkin soup	Nutritious and delicious
		Boiling the pulp with the right amount of sugar	Pumpkin jam	Nutritious and delicious
		Roasting pulp in local oven	Confectionery like baking pumpkin cakes, bread among others.	The appealing pumpkin flour flavour gives fortified wheat a sweater taste and makes it more nutritious.
		Boiling pulp with already cooked beans	Fortification of other stew like beans	Pumpkin contains micronutrients such as β-carotene that the beans do not have.
		Squeezing the pulp to obtain juice.	(i) Pumpkin juice (ii) Pumpkin wine	Sweet pumpkins have high sugar content thus good sources of pumpkin juice and wine
		Drying the sliced pumpkin pulp and then grinding them into powder	Pumpkin pulp flour	The appealing pumpkin flour flavour gives fortified wheat a sweater taste and makes it more nutritious.
		Slicing pumpkin pulp	Pumpkin salads	Pumpkins are nutritious and can be consumed in their raw form.
	Leaves	Steaming the leaves as vegetables	Pumpkin leaf flour	The dry leaf flour has a long shelf life thus ensuring continuous supply any time, even in time of scarcity.
		Cooking the leaves with other sauce like beans	(i) Fortification of other stew like beans	(i) Pumpkin leaves contain micronutrients such as folic acid that the beans may not have.
	Seeds	Roasting the seeds	(ii) Packed ready to eat roasted seeds snacks. (iii) Pumpkin seed oil	(ii) To get higher profit returns other than selling a whole pumpkin with its seeds. (ii) High mineral content such as Zinc, Calcium and potassium.
		Drying the seeds and grinding to make flour	Seed flour applied to tea as a spice.	
		Cooking seed flour as sauce	Fortification of other stew like ground nuts	
	Flowers/ young pumpkins	(i) Cooking young fruits/flowers with leaves as vegetables (i) Cooking young fruits/flowers with other sauce such as ground nuts	(i) Dried flower flour (ii) Dried slices of young pumpkins	To increase shelf life but also to ensure continuous supply even during off peak seasons.
Medicinal values	Leaves	Crush and mix clean leaves with sieved ash and water	Pumpkin leaf syrup	(i) Presence of bio-active components in the leaves that can cure allergies. (ii) Presence of minerals such as iron, calcium, zinc, potassium. The leaves are also a good source of vitamins and folic acid.
	Pulp	Steaming the pulp	(i) Instant porridge. (ii) Weaning meal for babies.	Presence of vitamins, minerals and micronutrients such as β-carotene which is a strong anti-oxidant.
		Squeezing the pulp to obtain juice.	Pumpkin juice	Presence of micronutrients such as β-carotene which is a strong anti-oxidant.
	Seeds	Drying the seeds and grinding to make flour	Seed flour applied to tea as a spice.	(i) High Zinc content (ii) Presence of bio-active components

findings of Ondigi et al. (2008). The responsibility of family heads is to work hard and provide food and other basic needs for the survival of their family members (Furstenberg, 1998). On the other hand, some families are headed by women who have to supply the needs of their families. Most of the respondents at least had a minimal level of education of primary. Many of the respondents were in very remote (rural) areas where poverty levels are quite high; it is most likely that they dropped out of school due to lack of incentives to attain higher levels of education. Agriculture is practiced to obtain food for home consumption and the surplus is sold to get income to meet some of their crucial basic needs. This is in line with the observations made by Gollin and Rogerson (2010). The pumpkins are grown alongside other crops such as sorghum, millet, matooke, maize beans among others (Ngwerume and Grubben, 2004; MAAIF, 2003, UBOS, 2010), since pumpkin is considered as a supplementary food crop and food security crop consumed more often during periods of food scarcity by farmers (Ondigi et al., 2008). Thus there were more respondents who practiced intercropping than mono-cropping.

Pumpkin cultivation is mainly on small scale (less than half an acre of area cultivated) for one farmer, while some famers practiced pumpkin production on a commercial large scale of at least a hectare of cultivated area. This trend is similar to cultivation of other food crops in Uganda (MAFAP, 2013). Pumpkin production in Uganda is still very low due to the fact that it is not one of the mainstream crops grown in the country hence less emphasis is put in place to encourage its cultivation. Furthermore, most of the respondents reported that they do not have plenty of land to carry out monocultural pumpkin production due to the increasing human population that competes for the limited land resource. Most of the respondents were above 46 years of age with very few participants in the age bracket of 18-25 years. This is perhaps because knowledge about the benefits of pumpkin consumption to the human body has not been well passed on from elders to the young generation thus the young people tend to neglect growing pumpkins. Needless to say, most of the young people tend to migrate from the rural areas to urban areas to look for other jobs to earn a living rather than depending on agriculture since it is generally perceived that the agriculture has low rewards as noted by Ahaibwe et al. (2013). Some youths move to urban areas for better social amenities such as education services and they eventually do not return to rural areas to practice agriculture.

Pumpkin production systems, performance and utilization in Uganda

Pumpkin is mainly cultivated as a food security crop due its ability to stay on the shelf for quite a long period of time provided it is harvested when mature and good storage measures are put in place as reported by farmers. The pumpkins also act as food supplements for animals such as pigs, because they are nutritious as also noted by Prohens-Tomás and Nuez (2007). Farmers mainly use vehicles to transport their pumpkins to markets because the pumpkins are heavy, also to minimize post-harvest loss due to damage imposed on the fruit especially through loss of fruit stalk. A vehicle is a better means of transport than a bicycle or motor cycle. Some farmers who cannot afford to hire vehicles to transport their produce, especially subsistence farmers, use motorcycles, bicycles or even walk to the market if it is in the neighborhood.

Several practices are carried out by farmers to ensure that they obtain high pumpkin yields and among these, application of manure ranked highest. Manure mainly animal wastes such as goat dung and cow dung are applied to increase the organic matter in the soil. Manure enhances good soil quality for agricultural productivity and environmental quality to be sustained for future generations (Reeves, 1997). Weeding is carried out to remove unwanted plants which are potential competitors for the little available nutrients to ensure that the available nutrients in the soil are only utilized by plants of interest to the farmers. Mulching is done as one of the measures of conservation agriculture, using mainly dry grass to maintain soil moisture and also mulches prevent direct contact of the developing pumpkin fruit with the ground. Some farmers spray their pumpkins with synthetic insecticides and fungicides to control pests and diseases that can lower the crop's productivity despite their side effects as also noted by Wilson and Tisdell (2001) and Walter et al. (2004). But some farmers use organic and less harmful methods to repel insects such as planting the seeds with a regulated amount of coat meal as also noted by Dubey et al. (2010). Some farmers apply some ash to the soil before planting the seeds to increase the soil pH (Qin et al., 2017) especially during the rainy season when ferric soils tend to be too acidic (Young, 1974). This is to favour proper crop growth since the suitable pH for good pumpkin yields ranges from 6.0 to 6.5 (Kemble et al., 2000).

Several pumpkin varieties are grown by farmers. The several pumpkin varieties observed are attributed to the fact that the pumpkin is a monoecious plant thus they experience high rates of cross pollination. These pollination events can change the genetic identity of populations, giving rise to quite a number of varieties among the open pollinated populations (Robinson and Decker-Walters, 1997) such as those owned by many farmers in Uganda. Most of these were mainly known by local names described by farmers based on the fruit skin colour, shape and texture of fruit epicarp as also stated by Prohens-Tomás and Nuez (2007). According to the farmers' responses, Oziga was the most preferred variety

because it is generally a sweet variety with less water content. This eases the drying process during value addition for flour production unlike some varieties that have much more water content.

The major sources of market are the vendors who buy pumpkin heads from the farmers at low farm gate prices and in turn they make reasonable profits. This implies that pumpkin growing is a source of people's livelihood. The least sources of market as reported are events such as weddings because they are not held on a daily basis. Also, when served, pumpkin is a supplementary food. In addition, some people think that it is consumed by the vulnerable groups that are to say children and women as also reported by Ondigi et al. (2008).

The major challenges faced by pumpkin farmers are unpredictable rainfall patterns due to the effect of anthropogenic activities such as deforestation. This has greatly led to a shift in the climatic conditions and in turn has a negative impact on agricultural yields as noted by Adams et al. (1998) and Parry et al. (2004). The other big challenge is pests and diseases. This also lowers the pumpkin yields since some farmers especially in remote villages are not aware of the various pests and diseases that attack pumpkins. The most common pests are fruit flies as noted also by Ndoro et al. (2007). They attack the young fruit causing rotting of the fruit as their larvae develop within the fruit, aphids which suck fluids from leaves. The most common diseases are fungal infections such as powdery mildew, downy mildew which are very severe during humid conditions as also reported by Ngwerume and Grubben (2004).

Most of the farmers reported that they consume pumpkins mainly to boost their immune system and that of their family members. This can mainly be attributed to the presence of vital minerals, and micronutrients like vitamins and carotenoids of which many such as zinc, manganese, β-carotene, vitamin E, vitamin C among others are good antioxidants that render powerless the harm caused by free radicals. This eventually would result in a wide range of chronic and common diseases; for example coronary heart disease, malaria, diabetes, arthritis to mention a few (Tolonen, 1990). A deficiency of vitamins results in reduced resistance to disease (Finch and Onn, 1996; Holick and Holick, 2006; Makariou et al., 2011; Kitson and Roberts, 2012). Good eye sight is owing to the fact that pumpkins contain high amounts of β-carotene (Sharma and Rao, 2013). β-carotene is one of the few carotenoids that have provitamin A activity. β-carotene has 100% provitamin A activity better than α-carotene that has approximately 53% provitamin A activity. Also vitamin E and vitamin C are essential for visual health (Lien and Hammond, 2011). According to the review made by Caili et al. (2006), pumpkin is endowed with antidiabetic, antihypertension, antitumor, immunomodulation, antibacterial, antihypercholesterolemia, intestinal, antiinflammation and antialgic properties which further explains the medicinal values associated with pumpkin consumption.

Conclusion

Pumpkin cultivation in Uganda is mainly practiced on a small scale. Large scale commercial pumpkin production is still very low. From the survey, it was observed that mainly the elderly people above 46 years were involved in pumpkin cultivation and the youths were less involved. Pumpkin is a multi-purpose fruit vegetable in that all the parts of the plant can be consumed thus minimizing food wastage and also the plant can stay for quite long in shelf thus has the potential to act as a food security crop. There is a wide diversity of pumpkin varieties grown in Uganda thus this can form a good basis for pumpkin crop improvement. There are some attempts of pumpkin value addition taking place though still on a very small scale and in only a few places in Uganda such as Mityana. Nonetheless, it is important to note that conservation of the local pumpkin germplasm in Uganda has not been emphasized by the National Agricultural Research Organization since it is not one of their priority crops and therefore, this poses a risk of genetic erosion of some pumpkin landraces as exotic varieties are being introduced in the market.

Recommendations

More sensitization needs to be extended to the communities in Uganda about the relevance of consuming fruits and vegetables, the pumpkin being one of them as one of the efforts for human health improvement and fighting of malnutrition. Youths need to be encouraged and educated about pumpkin cultivation and on the different value addition avenues for pumpkin that can be potential sources of income and general socio-economic development. Farmers should be encouraged to keep records about their produce in order to track the progress of their agribusiness. There is need for farmers to form saving cooperative associations to gather resources together in order to expand the small and medium enterprises on pumpkin value addition to improve the income attained. This knowledge of pumpkin value addition needs to be shared with the local communities in other regions of Uganda to minimize post-harvest losses when there is plenty of pumpkin production, and in turn, this would improve on the general socio-economic wellbeing of the farmers involved. There is a need to set up a germplasm bank for the Ugandan pumpkin landraces for conservation and for future crop improvement to address challenges such as pests and diseases. A cost benefit economic analysis of value addition avenues needs to be studied to determine which avenue would give farmers the best income profit for their pumpkin produce.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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REFERENCES

Abukutsa-Onyango M (2007). The Diversity of Cultivated African Leafy Vegetables in Three Communities in Western Kenya. African Journal of Food Agriculture Nutrition and Development 7(3):1-15.

Acharya AS, Prakash A, Nigam A (2013). Sampling : Why and How of it? Indian Journal of Medical Speciaties 4(2):330-333.

Adams RM, Hurd BH, Lenhart S, Leary N (1998). Effects of global climate change on agriculture: an interpretative Review. Climate Research 11:19-30.

Ahaibwe G, Mbowa S, Lwanga MM (2013). Youth Engagement in Agriculture in Uganda : Challenges and Prospects, P. 106.

Bogdan RC, Biklen SK (2007). Qualitative Research for Education: An Introduction to Theory and Methods (5th ed.). Pearson Education, Inc.

Caili FU, Huan SHI, Quanhong LI (2006). A Review on Pharmacological Activities and Utilization Technologies of Pumpkin. Plant Foods for Human Nutrition 61(2):70-77.

Dubey NK, Shukla R, Kumar A, Singh P, Prakash B (2010). Prospects of botanical pesticides in sustainable agriculture. Current Science 98(4):479-480.

Finch JM, Onn NRG (1996). Effects of selenium and vitamin E on the immune responses of domestic animals. Research in Veterinary Science 60(2):97-106.

Furstenberg FF (1998). Social capital and the role of fathers in the family. Men in Families: When Do They Get Involved? What Difference Does It Make, pp. 295-301.

Gollin D, Rogerson R (2010). Agriculture, roads, and economic development in Uganda. NBER Working Papers 15863. National Bureau of Economic Research, Inc.

Hamisy WC, Makundi AH, Marandu D, Nkya MJ (2002). Evaluation of five accessions of Cucurbita maxima collected from different ecological zones in Tanzania. In: The Second International Workshop on Plant Genetic Resources and Biotechnology Report (Arusha, Tanzania, pp. 6-10.

Holick MF, Holick MF (2006). Resurrection of vitamin D deficiency and rickets Find the latest version : Science in medicine Resurrection of vitamin D deficiency and rickets. Journal of Clinical Investigation 116(8):2062-2072.

Johnson B, Turner LA (2003). Data Collection Strategies in Mixed Methods Research. In: Tashakkori, A.M. and Teddlie, C.B., Eds., Handbook of Mixed Methods in Social and Behavioral Research, SAGE Publications, Thousand Oaks, pp. 297-319.

Kemble JM, Sikora EJ, Zehnder GW, Bauske E (2000). Guide to commercial pumpkin and winter squash production. Alabama Cooperative Extension System. ANR-1041http://www.aces. edu/pubs/docs/A/ANR-1041/ANR, 1041.

Kitson MT, Roberts SK (2012). Review D-livering the message : The importance of vitamin D status in chronic liver disease. Journal of Hepatology 57(4):897-909.

Lien EL, Hammond BR (2011). Nutritional influences on visual development and function. Progress in Retinal and Eye Research 30(3):188-203.

MAAIF (2003). The Uganda Food and Nutrition Policy.

MAFAP (2013). Review of food and agricultural polices in Uganda. MAFAP Country Report Series, FAO, Rome, Italy.

Makariou S, Liberopoulo EN, Elisaf M, Challa A (2011). European Journal of Internal Medicine Novel roles of vitamin D in disease : What is new in 2011 ? European Journal of Internal Medicine 22(4)355-362.

Martins S, Ribeiro De Carvalho C, Carnide V (2015). Assessing Phenotypic Diversity of Cucurbita Portuguese Germplasm. The Journal of Agriculture and Forestry 61(1):27-33.

Ndoro OF, Madakadze RM, Kageler S, Mashingaidze AB (2007). Indigenous knowledge of the traditional vegetable pumpkin (Cucurbita maxima / moschata) from Zimbabwe. African Journal of Agricultural Research 2(12):649-655

Ngwerume FC, Grubben GJH (2004). Cucurbita maxima Duchesne. Record from PROTA4U. Grubben, GJH and Denton, OA (Editors). PROTA.

Ondigi AN, Toili WW, Ijani ASM, Omuterema SO (2008). Comparative analysis of production practices and utilization of pumpkins (Cucurbita pepo and Cucurbita maxima) by smallholder farmers in the Lake Victoria Basin, East Africa. African Journal of Environmental Science and Technology 2(10):296-304.

Parry ML, Rosenzweig C, Iglesias A, Livermore M, Fischer G (2004). Effects of climate change on global food production under SRES emissions and socio-economic scenarios. Global Environmental 14(1):53-67.

Prohens-Tomás J, Nuez F (2007). Vegetables I: Asteraceae, Brassicaceae, Chenopodicaceae, and Cucurbitaceae. Springer Science and Business Media P 1.

Qin J, Frederik M, Ekelund F, Rønn R, Christensen S, Groot GA, Mortensen LH, Skov S, Krogh PH (2017). Wood ash application increases pH but does not harm the soil. Environmental Pollution 224:581-589.

Ravani A, Joshi DC (2014). Processing for Value Addition of Underutilized Fruit Crops. Trends Postharvest Technology 2:15-21.

Reeves DW (1997). The role of soil organic matter in maintaining soil quality in continuous cropping systems. Soil and Tillage Research 43:131-167.

Restrepo MJ, Lelea MA, Kaufmann B (2016). Second-Order Cybernetic Analysis to Re-construct Farmers ' Rationale When Regulating Milk Production. Systemic Practice and Action Research 29(5):449–468.

Robinson RW, Decker-Walters DS (1997). Cucurbits. Cab International, Wallingford, Oxon, New York 226 p.

Sharma S, Rao R (2013). Nutritional quality characteristics of pumpkin fruit as revealed by its biochemical analysis. International Food Research Journal 20(5):2309-2316.

SPSS IBM (2011). 20.0 for Windows. Computer Software]. Chicago, IL: SPSS Inc.

Tolonen M (1990). Vitamins and minerals in health and nutrition. Elsevier.

UBOS (2010). Uganda Census of Agriculture 2008/2009. Crop Area and Production Report (Vol. IV).

UBOS (2014). The National Population and Housing Census 2014-Main Report, Kampala, Uganda P 71.

Walter M, Harris-virgin P, Thomas W, Tate G, Waipara NW, Langford G (2004). Agrochemicals suitable for downy mildew control in New Zealand boysenberry production. Crop Protection 23(4):327-333.

Whitaker TW, Bemis WP (1975). Origin and Evolution of the Cultivated Cucurbita. Bulletin of the Torrey Botanical Club 102(6):362-368

Wilson C, Tisdell C (2001). Why farmers continue to use pesticides despite environmental, health and sustainability costs. Ecological Economics 39:449-460.

Wortmann CS, Eledu CS (1999). Uganda's agroecological zones: A guide for planners and policy marker. https://cgspace.cgiar.org/handle/10568/54311

Young A (1974). Some Aspects of Tropical Soils. Geography 59(3):233-239.