

Review

Uganda's barley value chain: Opportunities, challenges, and strategic solutions

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Thirty-five years after barley's introduction to Uganda, its largely brewery-based value chain continues to face several challenges. An underdeveloped seed system, poor agronomic and post-harvest handling practices, and infrastructure and mechanization gaps are among the key challenges hindering local barley production, resulting in Uganda's brewing industry being heavily reliant on imported barley grain to meet its raw material needs. Enhanced national budget allocations to agricultural research and extension, accelerated infrastructure development, subsidized mechanization financing, and the promotion of farmer cooperatives could help the value chain realize its full potential. Implementing these solutions could lead to higher incomes for local barley farmers, increased employment opportunities in the value chain, reduced brewery production costs, and a broader tax base for Uganda.

Key words: Barley, brewery, seed system, Uganda, value chain.

INTRODUCTION

Barley's classification and suitability for use

Barley (*Hordeum* species) is an annual grass in the Triticeae tribe distinct for being the only genus with three single flowered spikelets at each rachis node, two of which are lateral (Von Bothmer and Komatsuda, 2011). Two-row barley has sterile lateral spikelets while six-row barley has fully or intermediately fertile lateral spikelets (Bull et al., 2017) (Figure 1a). *Hordeum* subspecies include *Hordeum*

vulgare (domesticated barley) and *Hordeum spontaneum* (wild barley) (Pourkheirandish et al., 2015). Barley domestication was mainly focused on selection against shattering at ripening, an essential characteristic of wild barley for seed self-dispersal in the wild (Sakuma et al., 2011). *Hordeum*'s diploid nature, however, permits for viable hybridization between domestic and wild types

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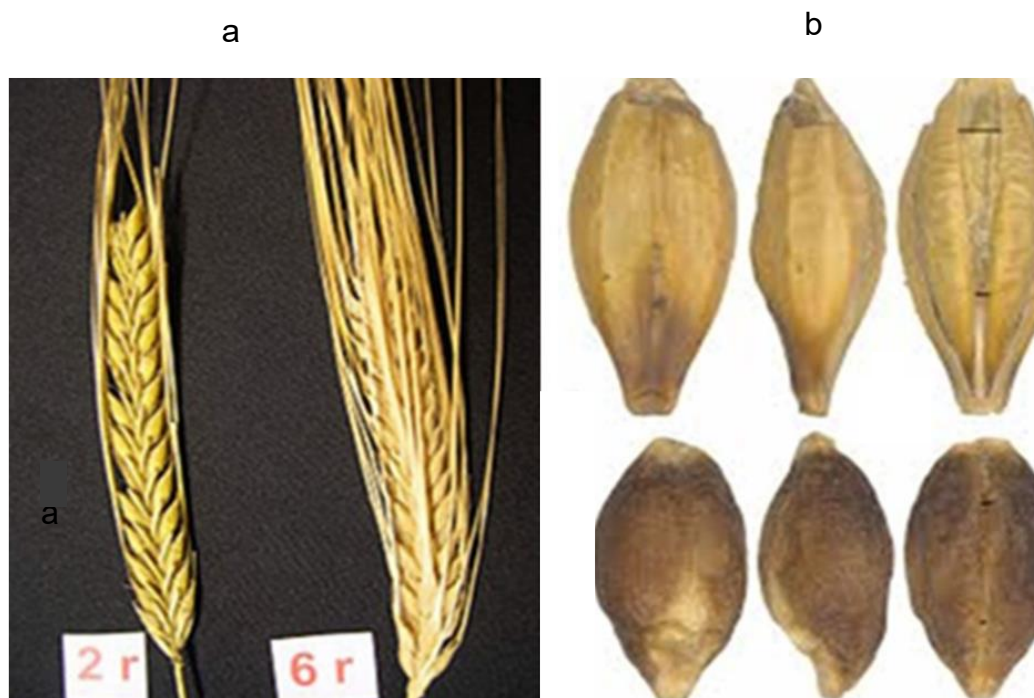


Figure 1. (a) Tow-rowed (2r) and six-rowed (6r) barley, (b) Hulled (a) and naked (b) barley. Source: Motuzaite Matuzeviciute et al. (2021).

(Weiss et al., 2006) reinforcing diversity and resilience under extreme environments (Blattner, 2018).

Both domesticated and wild barley types can be hulled or hull-less/naked depending on how tightly the hull (grain-skin) is attached to the grain (Vasan et al., 2014) (Figure 1b). Ecologically, these types can be winter, spring, or facultative. Winter barley's apical meristems require exposure to temperatures between 0 and 15°C for flowering induction (Makowska et al., 2015). This vernalization requires that barley is germinated in autumn for flowering induction in winter and subsequent development in spring and summer. Spring barley does not require vernalization for flowering (Comadran et al., 2012) making it widespread in most parts of the world, including Uganda. Barleys that have evolved to thrive under both winter and spring production regimes are termed facultative (Reith, 2024).

Two-row hulled spring barleys are popular for malting, distilling, and brewing because of their rich starch and protein kernel compositions (Vasan et al., 2014), a firm lemma and palea that protect the embryo during grain handling (Mulatu and Grando, 2011), and low post-maturation dormancy stemming from exposure to long and warm days. Naked barleys are popular for food and non-ruminant feed due to ease of processing and digestibility (Baik and Ulrich, 2008). Hulled barleys make decent ruminant feed owing to their good rumen fill and low predisposition to rumen acidosis (Nikkhah, 2012). Six-row barleys out-yield two-row barleys under similar conditions,

but their lower malting quality suits them more for food and feed (Mulatu and Grando, 2011).

Barley's origin

There are contrasting views about barley's origin. It has been suggested that there was a monophyletic near-East origin in the fertile crescent linking present day Syria, Israel, Jordan, and Iran, based mainly on evidence of cultivation of the crop in this area from as far back as 7000 B.C (Badr et al., 2000, Tanno and Willcox, 2012). Whereas this is the widely held view, some studies propose a polyphyletic origin. These include Molina-Cano et al. (1987) who suggested the Himalayas, Ethiopia, and Morocco as centres of origin; Morrell and Clegg (2007) who suggested two domestications, one in the fertile crescent and the other further east; and Dai et al. (2014) who suggested Tibet as another centre of origin. All these studies emphasize barley's ability to thrive in elevated, arid, and other marginal lands and together with its well-established value chain, attest to its position as the fourth most important cereal crop globally after rice, maize, and wheat (Galic et al., 2021).

Barley's introduction and distribution in Uganda

Despite its proximity to Ethiopia, a renowned African barley

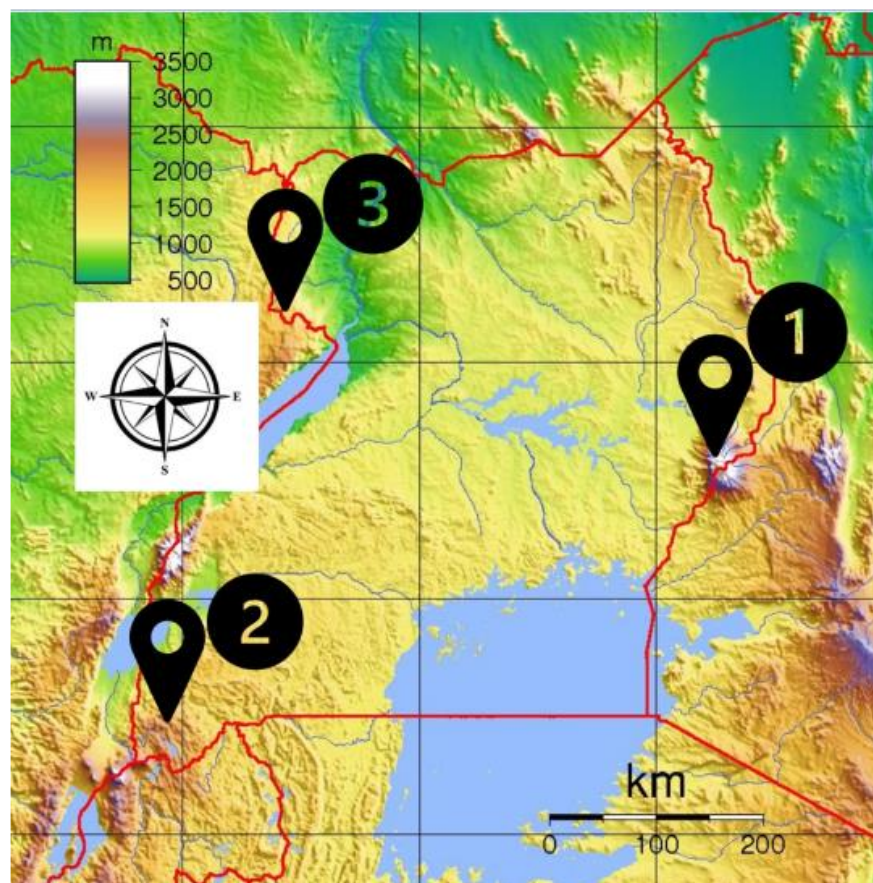


Figure 2. Barley producing regions of Uganda. 1 = Elgon region, 2= Kigezi region, 3= Zombo district.

producer and centre of diversity, barley was introduced into Uganda in 1990 by the Uganda Development Corporation and Uganda Breweries Limited (UBL) (2025), a subsidiary of the world's leading distiller - Diageo (Labu, 2016). The introduced germplasm were Kenyan cultivars (*Sabini*, *Karne*, and *Nguzo*) aimed to meet local demand by UBL (Cheptoyek, 2018).

Uganda's Elgon region (Figure 2), specifically the districts of Bukwo, Kween, and Kapchorwa were barley's points of introduction and continue to lead in its production to date. The new cash-crop's adoption in the predominantly coffee-banana cash crop system was further hastened in 2003 when ties between UBL and Kapchorwa Commercial Farmers Association (KACOFA) were reached (Cheptoyek, 2018). These ties saw UBL brew a new beer brand called Senator Extra Lager using 100% Ugandan sourced barley grain, guaranteeing market for Ugandan barley and thus spiking production in the region to approximately 1,000 ha by 2005 (Cheptoyek, 2018). For comparison, this acreage was approximately 1% of Ethiopia's 1.2 million hectares of barley grown in the same year (FAOSTAT stands for the Food and Agriculture Organization Statistical Database (FAOSTAT), 2024).

To minimize its production costs, Nile Breweries Limited

(NBL), a subsidiary of the world's leading brewer – AB InBev, and UBL's major local competitor, joined the effort to boost barley production in the region in 2010 (Labu, 2016). NBL sourced grain locally through the Mount Elgon Value Addition Crop Association (MEVACA), alongside introducing barley to the Kigezi region and Zombo district (Figure 2) (Kagorora et al., 2021; Monitor, 2021b; Roberts, 2013). At present, Mukaadamo Kawungye Barley Farmers Association and Kanyagabo Basigaba Farmers Association in Kabale and Kisoro districts, respectively host over 500 barley farmers in the Kigezi region alone (Afedraru, 2023).

Uganda's demography and suitability for barley husbandry

Uganda lies along the equator between latitudes 1.5°S-4.2°N and longitudes 29°E-35.2°E in East Africa (Ngoma et al., 2021). According to the Uganda Bureau of Statistics (UBOS, 2024), the country has a population of approximately 49 million people, with over 60% below 30 years of age.

This population is predominantly agricultural (>70%) despite low gross domestic product (GDP) contributions by

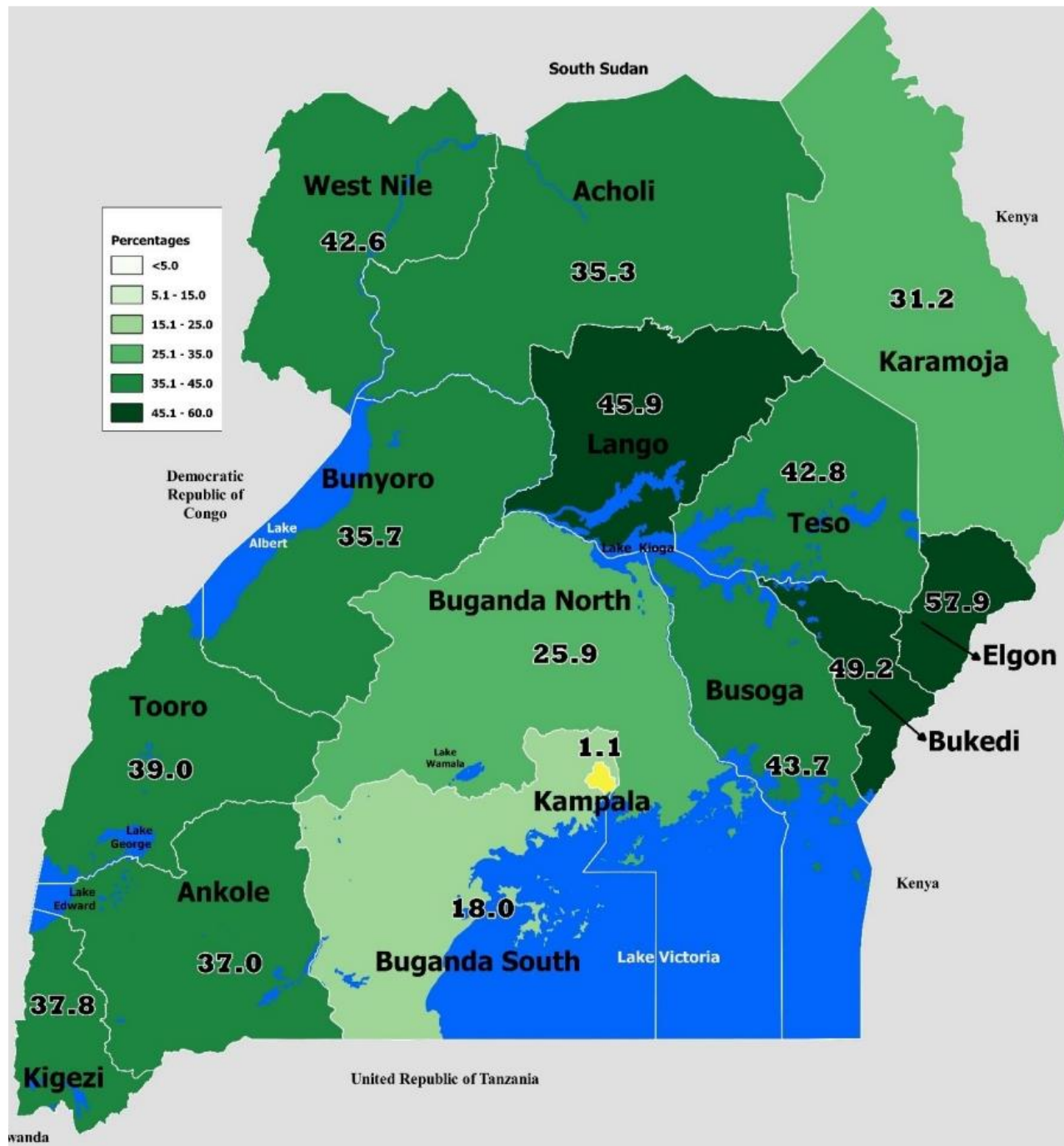


Figure 3. Uganda's working age population involved in purely subsistence agriculture by sub region. Source: UBOS (2024).

the predominantly subsistent sector (Figure 3), at only 22.28% in 2020/2021 and 22.95% in 2023/2024 (UBOS, 2024). As of 2020, the majority (60%) of Uganda's subsistence farmers were rural women aged below 30 with primary education being their highest educational attainment (Magunda, 2020). In the same year, UBOS reported up to 8.3 million Ugandans to be living in absolute

poverty, with an income of less than USD 2 per person per day (UBOS, 2024).

Of the 6.9 million arable hectares spread across Uganda (FAOSTAT, 2024), barley production is confined to altitudes >1800 metres above sea level due to the crop's temperature requirements. These altitudes are reached in the highland ranges, one of the ten agricultural production

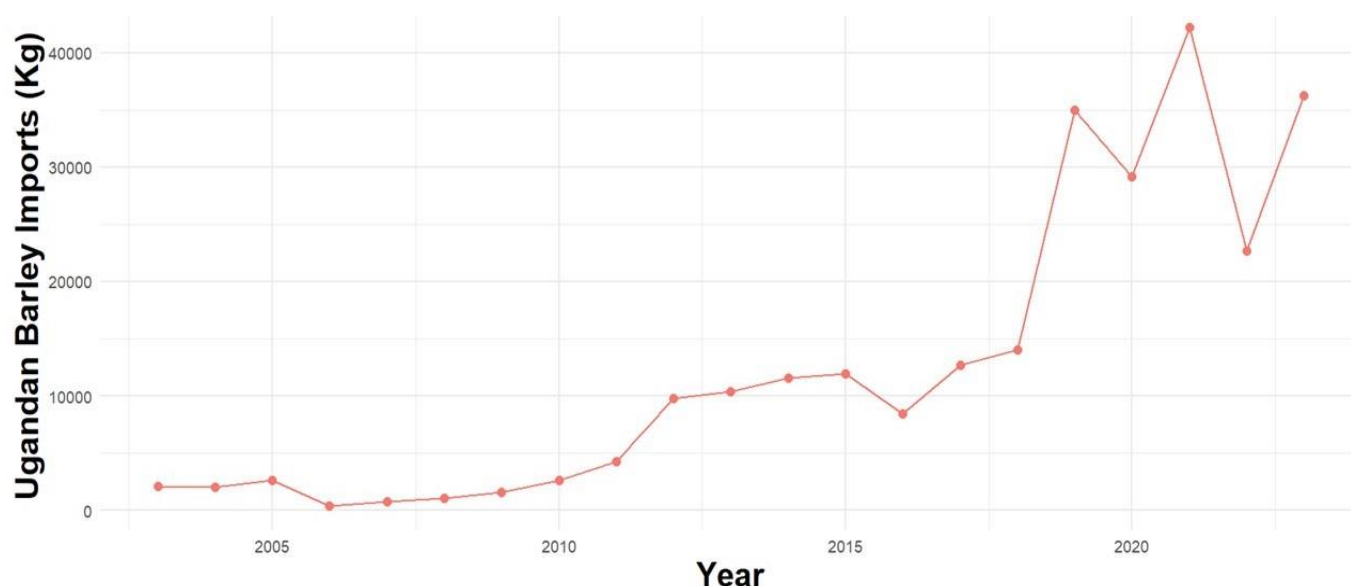


Figure 4. Uganda's barley imports.
Source: FAOSTAT (2024).

zones (APZ) of Uganda (Magunda, 2020). This APZ covers the greater Elgon, Kigezi, and Rwenzori regions together with west-Nile's Zombo district with mean annual temperatures ranging between 10.9 and 25°C (UBOS, 2024). Coupled with Uganda's bi-modal annual rainfall pattern, these elevated regions are conducive for spring barley production twice a year. However, Labu (2016) noted that only a quarter of this area was being utilised for barley production by 2009, probably due to the higher economic incentive offered by coffee, potatoes, and vegetable production when compared to barley in these regions. For the rest of the country, mean annual temperatures range between 26 and 32°C (UBOS, 2024). At these temperatures, barley inflorescences would suffer male sterility resulting in low or no yield (Abiko et al., 2005). In the wake of enhanced global warming, and the rising need to meet livelihood basics of the growing global populace, crop adaptation to heat stress as demonstrated by Marley et al. (2023) and Abou-Elwafa and Amein (2016) in barley is essential. The crop's ability to effectively thrive in arid, continental, oceanic, and sub-tropical climates (von Bothmer and Jacobsen, 1985) despite being largely native to Mediterranean ecosystems (Zohary et al., 2012) attests to its versatility. If successful, efforts towards developing heat resilient barley types would render the rest of arable Uganda, especially areas with altitudes close to the highland range APZ like Kabarole and Nebbi districts, suitable for barley.

Uganda's barley production and consumption

Among the approximately 145 million tons of barley

produced globally in 2021, 6.5 million tons were produced in Africa (FAOSTAT, 2024). Eastern Africa produced 2.25 million tons of these, with 2.07 million tons from Ethiopia alone, followed by 33 tons from Kenya. To date, Uganda's annual barley production is not clearly documented posing challenges to development planning and possible investment. On the other hand, Uganda's annual consumption of barley has seen a gradual increase from just 2.0 tons in 2003 to 36.2 tons in 2023 (Figure 4). In fact, 42.2 tons of barley valued at USD 3.7 million were imported by Uganda in 2021 (FAOSTAT, 2024).

Despite inadequate local production data, these figures point at Uganda being a net-importer of barley with implications like high alcohol production costs, farmer employment deprivation, and value chain uncertainty in case of global shocks to barley importation. The rise in European sourced barley importation costs by 87% in 2006-2008 due to drought and the biofuel production wave; Kenya's increased tax rates on non-malted beers and spirits going through its ports to landlocked Uganda in 2006-2008; the spike in European and North-American feed barley consumption in 2010 (Labu, 2016); and recent disruptions to barley production in two of the world's leading barley producers (Russia and Ukraine) due to tense political relations are evidence of the uncertainty faced by Uganda's barley value chain.

In a bid to reverse this trend, Uganda's government in 2008 lowered excise duty from 60% to 20% on alcohol produced using locally sourced grain (Parliament of Uganda, 2008), a move which saw local breweries prioritizing local grain sourcing over importation (Roberts, 2013). Despite the positive implications this tax reduction engendered, sub-Saharan crop production is still very

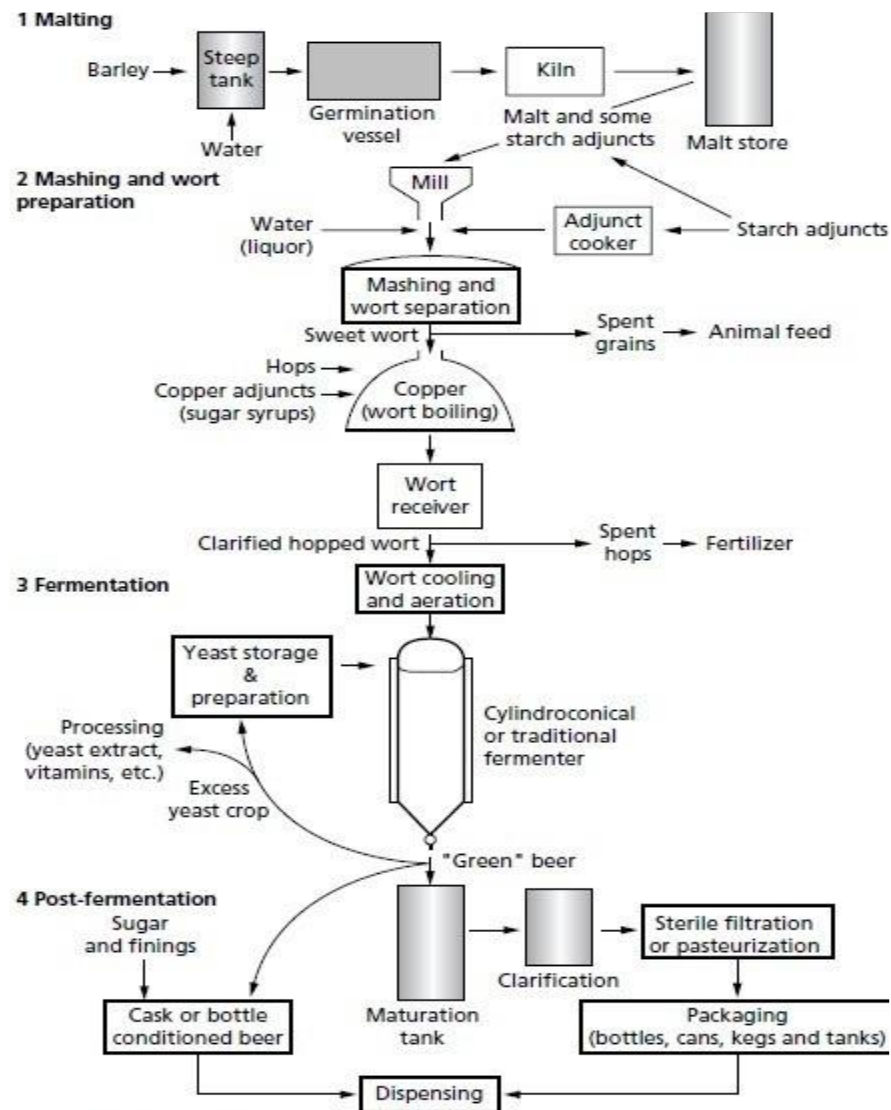


Figure 5. The malting and brewing process.
Source: Vivek (2019).

subsistent, a characteristic that culminates into high production costs for even lower and un-reliable yield. For comparison, in 2021, producing a ton of barley cost USD 421 and USD 214.9 in Kenya and Ukraine, respectively (FAOSTAT, 2024). Cognisant of this shortfall, the government recently instituted a 10% tax exemption on all barley grain imports for new enterprises in their first year of business (Uganda Investment Authority, 2024), a move whose impact is yet to be seen.

Ugandan barley's final uses

Malting and brewery

The majority of Ugandan barley grain is either malted or

used as an adjunct in brewing (Figure 5). This grain is mostly used for brewing by UBL and the production of malt by NBL for the production of their premium beer brands (Ugen, 2009). NBL launched its now 30, 000 MT per annum malting plant in November 2011 (NBL, 2012). To date, this remains the only malting plant in Uganda. Uganda's limited local barley supply has perhaps contributed to the absence of large maltsters despite the high demand for malted grain, exposing brewing companies to the high costs involved in importing malt.

Other crops that have found their way into the brewery in Uganda include cassava (*Manihot esculenta*) and alternative grains such as sorghum (*Sorghum bicolor* L), maize (*Zea mays*), and millet (*Panicum miliaceum*), that grow in majority of Uganda's arable ecologies. These crops have gained traction primarily due to the limited local

supply of barley (Kagorora et al., 2021). Dabija et al. (2021) report maize and sorghum to have richer starch contents than barley, making them good brewing adjuncts. On the other hand, barley has comparatively higher grain protein content than sorghum, maize, and millet suiting it as a good brewing enzyme source if its protein levels meet industry standards (Collar, 2014; Dabija et al., 2021).

Cassava, maize, and millet are, however, major human food and animal feed sources in Uganda and majority of Eastern and Southern Africa (FAOSTAT, 2024; Kubo, 2016), lowering their availability for brewing. Therefore, barley and sorghum are the principal grains for brewing in Uganda (Nishiura, 2014). The *Epuripur* variety of sorghum in particular, has been identified as a suitable ingredient for brewing, leading to the formation of farmer associations that aggregate and supply sorghum to Ugandan breweries (World Bank, 2018).

Animal feed

Globally, at least 60% of all produced barley is used directly as animal feed (FAOSTAT, 2024). In Uganda, however, the majority of barley's use as an animal feed comes in the form of spent brewer's grain (Figure 5), mostly accessible to small-medium sized peri-urban dairy and piggery farmers (Katongole et al., 2012). To a lesser extent, hydroponic barley fodder production has been embraced in Uganda's capital city peri-urban farming communities as shown by Alinaitwe et al. (2019). There have also been some efforts in the past by Kampala Capital City Authority (KCCA, 2025) through its agricultural resource centre to train peri-urban farmers on the hydroponic production of barley fodder to supplement their dairy, piggery, and poultry diets, although these came to a halt citing a lack of availability of barley seed. Ugandan fish farms have also been reported to use barley as an algaecide, minimising algae growth in fishponds (Afedraru, 2023).

There continues to be a glaring need to maximise barley's potential as an animal feed grain by Ugandan animal feed manufacturers and livestock farmers with its benefits including lower processing costs when compared to maize – the main feed carbohydrate source in Uganda; good rumen-fill and easy non-ruminant digestibility of hulled and naked barleys, respectively. This un-tapped field could offer alternative markets for Uganda's barley farmers, especially when their grain doesn't meet brewery requirements.

Barley's contribution to Uganda's economy

Several studies have pointed to barley's positive socio-economic implications on Uganda's producing households citing indicators like affording balanced diets, children's school fees, health care, and more (Roberts, 2013; Labu,

2016). The crop's power to transform livelihoods has so far been hinged on its in-satiable local brewing value chain that connects farmers and other players to the money economy.

With a consumption of 12.21 L per capita per year, Uganda tops African alcohol consumption (World Health Organisation [WHO], 2023). The Uganda Revenue Authority (2024) reports that at least 95% of all the alcohol produced in Uganda is consumed locally, making beer the country's leading major excisable product, with distilled spirits following closely behind. This consumption base has supported local alcohol manufacturers, placing two of them (UBL and NBL) among the top five annual taxpayers (Uganda Revenue Authority, 2024). Together, brewery and other industries in the food and beverage manufacturing sub-sector contributed 16.4% to Uganda's GDP in 2020/2021 (FAOSTAT, 2024).

ENHANCING UGANDA'S BARLEY PRODUCTION

Financing

The majority of the interventions to enhance Uganda's barley production require capital investment that is limited given Uganda's high poverty rates, necessitating national budget allocations, customised credit facilities, foreign direct investment, and donor aid among other capital sources. The country's national budget allocations to agricultural development are still meagre ranging from 2.28% in 2020/2021 to 2.61% in 2024/2025 (Ministry of Finance, Planning, and Economic Development, 2025). The sector is, therefore, heavily reliant on donor aid, foreign direct investment, credit, and private investment sources.

Approximately 6% (USD 217 million) of all donor aid commitments to Uganda in 2021 were meant for developing the agriculture sector (agriculture, forestry, and fishing). Among these, approximately USD 215 million targeted agriculture inclusive of food production (USD 5.27 million), basic nutrition (USD 15.2 million), food assistance (USD 16.4 million), emergency food assistance (USD 112.4 million), with only USD 3.88 million allocated to the production of industrial crops like barley, and USD 1.83 million to agricultural co-operatives. On the other hand, the agro-industry sub-sector was allocated USD 0.136 (Figure 6) million with only USD 0.071 million targeting agro-industries (FAOSTAT, 2024).

These figures point to a less agro-industrialisation centred donor capital base, and the need for higher national budget allocations towards agriculture. Uganda's foreign direct investment grew from USD 829 million in 2018 to approximately USD 1,526 million in 2022, although agriculture's allocation from these funds fell from approximately USD 58 million in 2018 to about USD 19.2 million in 2020 (FAOSTAT, 2024). Similarly, agricultural credit averaged at USD 610 million in 2022, making up

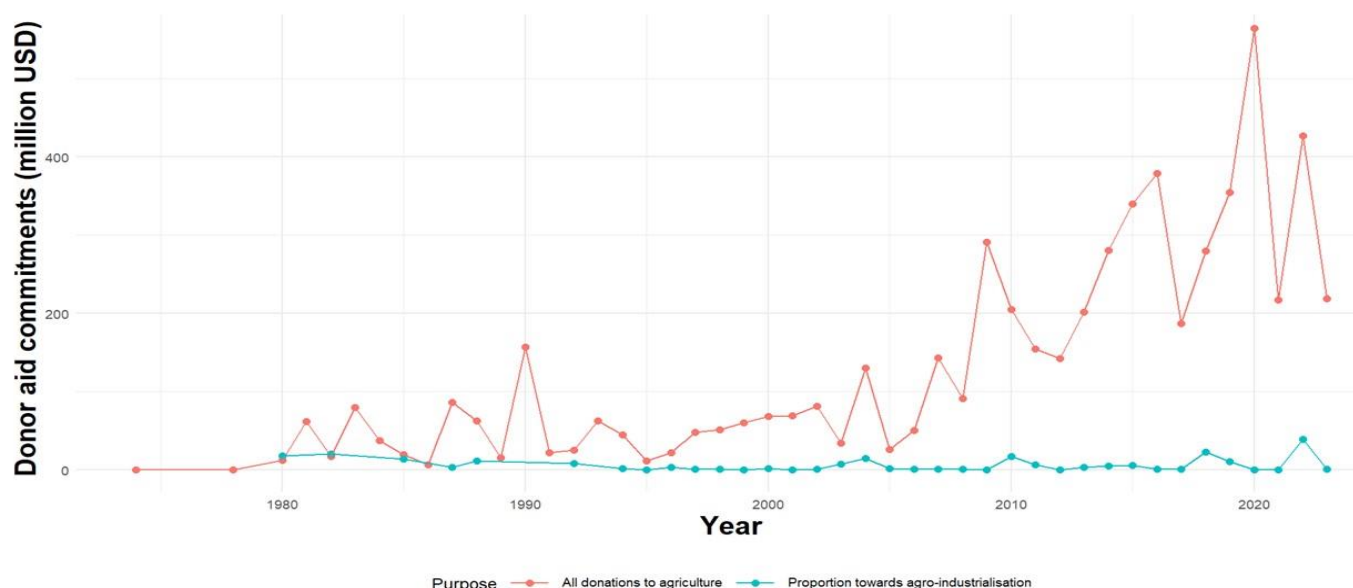


Figure 6. Donor aid commitments to Uganda's agricultural sector. Adopted from: FAOSTAT (2024).

only 11% of total credit value (FAOSTAT, 2024). The government used its central bank to launch the Agricultural Credit Facility in 2009 (African Development Bank Group, 2025). Through partnering with local commercial banks and Uganda's Development Bank, the central bank aimed to subsidize credit-based financing for agricultural enterprises in the country, notably structural and machinery investments, grain trade, among others. Ten years later, the facility had disbursed up to USD 83.8 million to 492 beneficiary projects across Uganda. It also spurred complementary innovation of financial products by local banks and microfinance institutions for the country's agricultural sector (Ministry of Finance, Planning, and Economic Development (MOFPED), 2019).

Risk management

Agricultural foreign direct investment and credit financing as capital bases have the potential to grow but are hindered by agriculture's significant risk. To enhance their growth, the government partnered with Uganda's Insurance sector through its Agricultural Insurance Scheme to advance subsidized insurance cover for crops and livestock, although its uptake remains significantly low among farmers (Insurance Regulatory Authority of Uganda, 2024). This scheme, however, does not cover barley crops.

Public infrastructure

Cheptoyek, (2018) highlighted on the impassable roads in the Elgon region that hindered transportation of barley

grain upon harvest. Furthermore, electricity transmission is still inadequate for most parts of the country, despite it being a major driver of mechanised post-harvest handling practices such as barley grain drying. Uganda's government in its third National Development Plan (National planning Authority [NPA], 2020) committed to class-B national roads for the Elgon and Kigezi regions (Figure 7), a move that will greatly enhance economically sustainable barley production in the country.

The government's commitment to integrated transport and energy infrastructural development all over the country is also evident in its fourth national development plan (NPA, 2025) and vision 2040 (NPA, 2007).

UGANDA'S BARLEY SEED SYSTEM

Variety development

Uganda's formal crop improvement research is still predominantly practiced by the government's National Agricultural Research Organisation (NARO). NARO heavily relies on external funding through grants and donations to execute its objectives, with food security thematic areas attracting the most funding. Private entities like seed companies and distributors heavily rely on NARO's research out-puts for their product portfolio. NARO's Buginyanya Zonal Agricultural Research and Development Institute (BugiZARDI) hosts Uganda's national barley improvement program. BugiZARDI is located on the slopes of Mt. Elgon, placing it at the centre of Uganda's pioneer and leading barley producing region. Following rigorous evaluation, the program reached a key



Figure 7. National development Plan III road projects.
Source: National Planning Authority (2020)

milestone in 1996 when the three brewing barley varieties introduced from Kenya in 1990 were registered as barley varieties in Uganda (Ministry of Agriculture, Animal Industry, and Fisheries [MAAIF], 2022). This was followed by the evaluation and registration of one South African Barley Breeding Institute (SABBI) derived malting barley variety (SSG 562) in 2005. Further collaborative evaluation by the program and SABBI resulted in the registration of two other malting varieties (Hessekwa and T279) designated as NARoBar1 and NARoBar 2 respectively in 2017 (SABBI, 2019; MAAIF, 2022). At present, this program is working towards improving disease resistance and grain yield through conventional plant breeding

approaches (NARO, 2023b). Although transgenic approaches are accepted for research purposes in Uganda (Parliament of Uganda, 2017), the program has not yet embraced them as their research agenda is mainly informed by local breweries who are the major end users of the crop. The increasing need for local self-sufficiency as far as raw material sourcing by Uganda's breweries has fuelled the program to develop four more candidate barley lines. These lines are currently undergoing Distinctness, Uniformity, and Stability (DUS) tests before release. The lines mature in 100-110 days with projected yields of 3.0-3.5 tha^{-1} , good brewing quality, superior net-blotch and barley-scald disease resistance, alongside adaptation to

elevations of >1800 m above sea level (NARO, 2023b). The program, however, still grapples with several challenges, markedly limited funding.

Variety release and licensing

Upon development, new plant varieties are not patentable in Uganda. Therefore, plant breeders and/or their organisations do not receive royalties for their inventions (Uganda Legal Information Institute, 2014). This regulation continues to raise concerns about how sustainable plant breeding research is if it's not funded by its end-users. To counteract this, NARO has embarked on variety licensing upon release, based on provisions within Uganda's Plant Variety Protection Act (MAAIF, 2014) that designate the plant breeder as the maintainer of their released varieties (NARO Variety Allocation List, 2023a). With this move, NARO claims monies from every unit of its commercialised varieties sold by seed businesses, further funding their crop improvement programs. So far, none of NARO's registered barley varieties have been licensed probably due to their failure to meet licensing criteria or lack of expression of interest by local seed businesses.

Early generation seed

Early generation seed (EGS) includes breeder, pre-basic, basic, registered, and foundation seed. Barley EGS production and analytical standards for Uganda have been developed by the National Seed Certification Service (NSCS) (MAAIF, 2016). Legally, NARO is mandated to produce these seed classes (MAAIF, 2018). For barley, however, there is no documented EGS production since the grown varieties are all imported as certified seed.

Certified seed and contract out-growing

Like EGS, barley certified seed production and analytical standards have been developed by the NSCS (MAAIF, 2016). Private seed companies are the only entities mandated by law to produce certified seed in Uganda (MAAIF, 2018). To date, however, there are no known seed companies involved in certified barley seed production in Uganda.

To bridge this gap, brewing companies outsource barley certified seed from breeding companies of their choice outside Uganda. They then distribute them together with other farm inputs to contracted Ugandan barley farmers individually and/or through farmer co-operatives at the beginning of each season (Cheptoyek, 2018). Due to public system inefficiencies, this seed may not always go through rigorous formal testing procedures for imported seeds, leaving its quality wanting. Previously, there have been claims by farmers about receiving seed that does not germinate from brewing companies, leading to poor crop

stands and subsequently low yields (Cheptoyek, 2018). Some farmers were reported to resort to smuggling un-certified barley seed from neighbouring Kenya, exposing local farming communities to invasive weeds and pests (Cheptoyek, 2018). These issues highlight the role Uganda's national plant protection organisation needs to play in enforcing International Seed Trade Association standards at seed importation borders.

At harvest, brewing companies offset input costs from the farmers' end of season grain sales at prices pre-determined in their out-grower contracts. Mbogo (2013), however, hinted at the un-trustworthiness of Ugandan barley farmers, citing cases of selling to the highest bidder despite signing out-grower contracts. Aside from ambiguous seed quality, this arrangement does not support local private seed companies that could profit from importing and distributing barley certified seed to farmers. However, if managed well, the arrangement has the potential to ensure that Uganda's barley farmers embrace seasonal purchase of barley certified seed despite it being a self-pollinating crop whose seed can be recycled. This would in-turn, result in greater revenues for supplying seed businesses, and guaranteed results for the farmers as recycling reduces seed quality.

UGANDA'S BARLEY AGRONOMIC PRACTICES

Choice of season

Cheptoyek, (2018) noted that the majority of Uganda's barley was grown in season B spanning August to November. Aside from having more rainfall, season B is popular for its successive 60 to 75-day dry spells that allows for efficient pre- and post-harvest grain drying, processing, alongside feeder road usability for timely access to grain markets (Cheptoyek, 2018). Investing in affordable on-farm drying equipment, farming co-operative-based grain drying infrastructure, and all year feeder road access will greatly enhance barley production in the un-popular season A (March-June), potentially doubling annual grain supply. To this end, NBL launched its USD 1 million barley drying and cleaning plant in the Elgon region's Kween district in 2023 with a second plant under construction in the Kigezi region's Kabale district (New Vision, 2020). With a 250-ton daily processing capacity, private sector led investments like these are bound to boost local barley supply, although their associated challenges like trade monopolization should not be ignored.

Seed bed preparation

Barley seed bed preparation in Uganda's growing regions predominantly involves oxen ploughing (Figure 8), although tractor and herbicide use are slowly gaining popularity (Cheptoyek, 2018). The small amount of land (0.5-3 acres) apportioned for barley cultivation in these



Figure 8. Seed bed preparation in Uganda using oxen ploughing.
Source: New vision, (2020).

largely mixed-farming households, the hilly terrain, and the low purchasing power for large farm machinery renders this rudimentary method the most affordable. For comparison, the price of a farm tractor in Uganda was USD 41,000 as of March 2025 (Tractors Uganda, 2025) while a pair of oxen costs USD 1,100 on average. Draught power, however, is posed with a myriad of challenges, the most apparent of which is insufficient animal feed especially at peak ploughing times. This greatly reduces oxen efficiency thus negatively affecting the timeliness of subsequent crop-husbandry routines and eventual yield. Hand ploughing is often used to cover for these shortfalls, although it increases production costs (Cheptoyek, 2018). There is need to invest in co-operatively owned machinery for better timeliness of barley farming activities (NBL, 2012).

Fertiliser application and sowing

Beyond seed bed preparation, farmers apply Di-Ammonium Phosphate (DAP) fertiliser to their fields before

broadcasting 111 to 123 kg ha^{-1} of seed despite the recommended 99 kg ha^{-1} of seed (Cheptoyek, 2018). Barley crops are then top dressed mainly with Urea between their mid-late tillering growth stages. Like many other crops in Uganda, barley fertiliser application rates are predominantly determined by input suppliers rather than by individual pre-planting farmer-field soil testing, thus vary between suppliers.

Barley crop protection

Cheptoyek (2018) highlighted *Biden pilosa* as the prevalent weed in Ugandan barley fields, alongside others like *Amaranthus* species and *Digitaria abyssinnica*. Farmers were inclined towards chemical weed control due to its ease of use in their broadcasted barley fields. Selective herbicides targeting broadleaved weeds in established barley fields, preceded by a non-selective herbicide pre-planting was noted as the most preferred combination for weed control. Aside from leaf rust (*Puccinia hordei*) and white grubs (*Phyllophaga*

trichophora), barley pest and disease prevalence in the Elgon region was reported to be minimal requiring little to no post-planting intervention (Cheptoyek, 2018).

Afedraru (2023), however, mentioned the significant reduction of Ugandan barley yields by *Fusarium* head blight, net blotch, spot blotch, birds, and vermin although the contributions of each to yield reduction has not been documented. Talwana et al. (2008) also reported the occurrence of three nematode species (*Ditylenchus* species, *Helicotylenchus dihystra*, *Pratylenchus* species) in Ugandan barley fields although their economic value was not ascertained. There were concerns, however, on the farmers' ability to correctly apply herbicides and pesticides owing to their low literacy levels (Cheptoyek, 2018). Generally, information on barley's crop protection requirements for Uganda remains limited to date.

Harvesting and yield

Barley plants are cut with sickles at harvest maturity for subsequent post-harvest handling (Cheptoyek, 2018). At 1.9 tha^{-1} , average on-farm yield is below NBL model farm (3.7 tha^{-1}) and research-station (3.5 tha^{-1}) yields (NBL, 2012; NARO, 2023b). Compared to the 2.2–2.6 tha^{-1} produced by the world's largest barley producer (Russia) between 2019 and 2023 (FAOSTAT, 2024), these yields are lower despite the higher small-holder costs of production in Uganda.

The need for a regulated and well-informed agro-input supply base providing quality inputs and after-sale services to barley farmers, alongside regularly trained extension teams is pivotal in ensuring that the best barley agronomic techniques are adopted for better yields. At present, NBL, UBL, farmer co-operatives like KACOFA and MEVACA, are leading the farmer training initiative with company/organisation agronomists directly interfacing with their contracted farmers. This is through initiatives like UBL's Local Raw Material program (UBL, 2025). Several development partners inclusive of *Solidaridad* and *aBi* development limited are also involved in barley farmer training programs (Afedraru, 2023), while the government's contribution through its local government agricultural extension service and NARO remains negligible due to limited funds. None the less, these efforts have registered a yield increase for Uganda's barley producers in the Kigezi region from just 400 kg ha^{-1} in 2020 to 1,200 kg ha^{-1} in 2022 (Afedraru, 2023).

POST-HARVEST HANDLING

After harvest, the majority of the farmers thresh their barley by hulling it with wooden sticks on tarpaulins, consequently winnowing it to remove debris, and sun drying it to a hard consistency (Cheptoyek, 2018). Heavily reliant on free family and cheap casual labour, this process is the most affordable for most of Uganda's barley producing

households. If the grain is not harvested at the right moisture content such rudimentary threshing methods pose a high risk of skinning which compromises grain quality (Monitor, 2020). Weed seeds and chaff also reduce grain quality if winnowing is not done correctly due to human error. Together with insufficient grain drying, these issues cost Ugandan barley farmers in post-harvest losses each year. The African Post Harvest Losses Information System (APHILIS) estimated that up to 637 tons of Ugandan barley were lost post-harvest in 2022 alone, constituting 12.5% of annual production (APHILIS, 2025).

Ideally, grain should have moisture content of 13.5% at harvest maturity and through-out its post-harvest handling (Afedraru, 2023). This moisture content limits grain quality deterioration from moulding, alongside limiting storage insect pest infestation (Khajeh-Hosseini et al., 2024). Accurately estimating this moisture content requires moisture meters although these are not commonly used by farmers with claims of high costs of acquisition. As of March 2025, online grain moisture meter prices in Uganda varied between USD 55 – USD 245. Whereas government subsidized prices and the possibility of private grain buyers and/or development partners investing in purchasing this equipment for the farmers may seem worthwhile (NBL, 2012), it is more sustainable if these farmers are sensitised about the value this equipment adds to their businesses, and perhaps mandatorily required to privately acquire it before signing out-grower contracts.

Along with co-operatively and/or privately owned drying and storage facilities within these farming communities, post-harvest losses can be minimised. The NBL drying facilities in Kween and Kabale districts are positively contributing towards this cause (New Vision, 2023).

Cheptoyek (2018) reported that only a few Ugandan barley farmers were using motorised threshers. Together with the high cost of purchasing and/or hiring these machines, feeder road impassability at peak harvesting times limits their transportation to barley farms. This impassability also leaves farmers relying mainly on donkeys (*Equus asinus*) for post-harvest transport of grain from farms (NBL, 2012), limiting the timeliness of post-harvest practices. In a bid to maximize local raw material sourcing, UBL in its Farm for Success program has invested in purchasing mechanical threshers for Uganda's barley farming households to minimize post-harvest losses (The Independent, 2023). Private company corporate social responsibility endeavours like these, together with public sector instruments like subsidized agricultural credit facilities for machinery purchase will go a long way in ensuring Uganda's barley farming communities' transition to mechanised post-harvest handling for reduced grain losses.

GRAIN AGGREGATION AND PRICING

Farming co-operatives like KACOFA and MEVACA lead the procurement of barley grain from their contracted

farmers at a price pre-determined by brewing companies which form 90% of their market (Afedraru, 2023). These prices are subject to prevailing legislation such as the recent amendment of taxes on alcoholic beverages made from local and imported grain to 60% and 100%, respectively (Parliament of Uganda, 2024). Some large private grain aggregators such as Agroways Uganda Limited (AgroWays (U) Limited), and recently small-medium sized middlemen, are also involved in buying grain directly from farmers. The current locally produced barley quantities are, however, insufficient to meet local demand. In 2021, NBL alone needed 15 tons of barley for malting, yet it could only source 4.5 tons locally thus importing over 8 tons from Australia at high import tariffs (Monitor, 2021a).

As of 2021, the average global price for a kilogram of barley grain at farm gate was USD 0.178 (Federal Reserve Bank of St. Louis, 2025), a value less than the average price paid out to Ugandan farmers for a kilogram of barley in the same year (USD 0.22). However, the cost incurred to produce a kilogram of barley in the same year was USD 0.18, leaving a USD 0.04 margin (Monitor, 2021a). Buying entities off-set the cost of in-puts provided to farmers at the beginning of the season, further shrinking this margin. With the staggeringly low yields, farmers are left with an average net margin of USD 48 per acre of barley (Monitor, 2021a); translating into USD 12 for each of the four months barley takes to grow to maturity. There is an obvious public outcry about how low farm gate prices are among Uganda's barley farmers.

However, with only a few buyers available, the Ugandan barley market does not offer many alternatives for its dissatisfied farmers. Brewing companies continue to review and update these prices annually to check the economic viability from their perspective (Monitor, 2021a).

Quality checks

Ugandan barley aggregators generally screen for grain with an acceptable moisture content (<13.5%) and a germination rate of at least 95% (Afedraru, 2023). Grain that falls short of these requirements is rejected, as it cannot be used by the breweries. A case in point is the barley grain rejection by NBL in 2020 due to high moisture content and low germination capacity that saw at least 10 tons of farmers' produce rot away at their collection centres in Kapchorwa (Monitor, 2020).

In its *US EAS 327:2023* specification, Uganda's National Bureau of Standards (UNBS, 2025) also outlines a voluntary standard for assessing the quality of barley grain destined for malting and brewing at a cost of USD 8.17 per sample, although this remains mainly un-utilised.

CONCLUSION

Leveraging on its natural predisposition as regards climate

and a young workforce, Uganda's budding industrial sector could considerably contribute to lowering poverty rates through local agricultural product value addition as is the case with barley. Concerted efforts from the public and private sector as far as policy and development initiatives are, therefore, critical if barley's socio-economic transformation potential is to be achieved in Uganda. The recommendations below could potentially contribute to growing the country's barley value chain.

RECOMMENDATIONS

Data for information of policy

Policy amendments like devoting national funds towards barley's agricultural research, feeder road construction in barley producing regions, inclusion of barley in the agricultural insurance subsidy program, enhancing public agricultural extension services to barley producing regions, among others will rely on the availability of barley production, trade, and consumption data. Farmer co-operatives and other private entities in the crop's value chain should periodically update and publicly avail such data to the UBOS for information of policy on the crop.

Strengthening barley's formal seed system

Robust formal seed systems are dependent on the presence of vibrant plant breeding programs. Therefore, national budget allocations towards local variety development for the crop need to be increased. Furthermore, pooled private company funding towards local barley improvement by its national improvement program for common good would significantly supplement national budget allocations for development of improved locally adapted barley varieties.

To further hasten variety development, amendment of Uganda's Industrial Property Act (MAAIF, 2014) to allow research businesses like SABBI to profit from the development and sale of own barley varieties in the country would greatly encourage them to set-up in Uganda. Such a move would, however, require that food crops are exempt from this amendment to ensure food security in the predominantly impoverished nation.

Local seed businesses should be involved in the sourcing, maintenance, and distribution of certified seed stocks for the crop. Whereas the choice of imported varieties can be at the main end-users (brewery) discretion, these local seed businesses will develop their organisational, infrastructural, and professional capacities to import, produce, process, market, and distribute quality barley seed in Uganda, potentially gaining interest in the locally registered barley varieties. If merged with the out-grower contract based off-set of input costs by Uganda's brewing companies, such a move would not only foster local accountability for seed quality but also guarantee

quality seed seasonal sales of the self-pollinating crop. This would ensure seed business continuity and widen the country's tax-base.

Concerted research efforts

Uganda's national barley improvement program could gain from forging collaborations with global barley research organisations like the International Centre for Agricultural Research in the Dry Areas (International Center for Agricultural Research in the Dry Areas [ICARDA] - CGIAR) and the International Barley Hub (Home - Barley Hub). These links would foster barley biodiversity mobility and technology access for the country's juvenile research program. Local research agenda costs could also be reduced through the establishment of a legally recognised private sector led research body exploring all value chain aspects.

Such an organisation would allow for private entities to locally access affordable research procedures tailored to their needs, that they would previously have to run in-house or internationally out-source at hefty costs. Scotland's Scotch Whisky Research Institute (SWRI) is a typical example of such an organisation. Together, the above arrangements would contribute to local research capacity development if adequately merged with training institutions like universities.

Farmer education

There is need for more public and private sector investment in farmer and extension worker sensitisation regarding barley agronomy. This sensitisation should strongly highlight the advantage of pooling land resources by farming households into barley production to increase their chances at meaningful mechanisation.

Mechanisation cost subsidization

Primary investment in making the locally adapted draught power better and more available before heavily investing in more expensive and sophisticated machines will positively influence its adoption. For the latter, acquisition of expensive machinery could be more sustainable through purchasing-cost subsidies and customised credit interest rates by the government, than through free machinery distribution projects that may not give farmers a sense of ownership over the machinery.

Barley for human food

So far, there are no documented local uses of barley for human food (bakery, porridge, among others) in the highly undernourished country (UBOS, 2024), despite the crop's

immense nutritional advantages. Reports by Bhatta (1999) and Sakellariou and Mylona (2020) show the higher β -glucan content of barley in comparison to other cereals. This higher β -glucan content gives barley a low glycaemic index making it suitable for use in diets of diabetic and heart health patients (Verstegen et al., 2014, Arias and Bhatia, 2015). Coloured barley is rich in anthocyanins, a group of water-soluble flavonoids under the polyphenol family of biomolecules (Zhu, 2018). Found in high amounts in the bran especially of purple barley, these compounds have been reported to have strong antioxidant properties (Lee et al., 2013). Purified extracts from this bran have been tested for use in several anti-inflammatory disease treatments where they have shown good reactive oxygen species reduction and cell viability maintenance among other important qualities, suggesting their possible use in such therapies (Zhang et al., 2021). Barley has also been reported to be a good vitamin E source by Sakellariou and Mylona (2020), adding that it is the only cereal containing all eight isomers of this vitamin.

Exploring the therapeutic human food avenue could provide an alternative market for Ugandan barley, thus enabling farmers leverage on the benefits of the competition this will bring with its current brewing customers.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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