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GHEE-MAKING IN THE CATTLE CORRIDOR OF UGANDA

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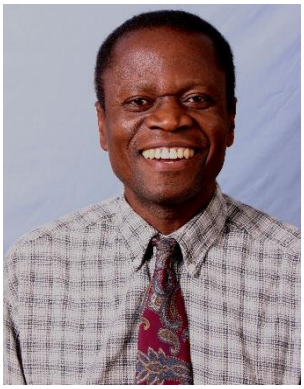

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ABSTRACT

In sub-Saharan Africa, women in smallholder dairy operations carry a disproportionate labor burden, especially in making traditional fermented milk products like ghee. There is a clear need to improve the production processes, not only to decrease the labor burden, but also to increase quantity and enhance quality. The objective of this study was to document the current butter/ghee-making practice and to identify priority areas that need attention. Women groups engaged in traditional butter/ghee production were identified from the cattle corridor of Uganda. The five study locations were: Ngoma village/town in Nakaseke district, Nyamilinga and Kabuye villages in Kiboga district, Kanyaryeru village in Kiruhura district and Kotido in Kotido district. The women demonstrated the processes and were engaged in focus groups to better understand details that were not adequately covered during the demonstrations. The demonstrations were video-taped for future reference. Butter is made from the milk of a cow that has been lactating for at least one month. Milk and/or cream are allowed to ferment for up to 12 hours and butter is separated by churning in a gourd. The butter/ghee-making practices in the cattle corridor of Uganda differ in how the milk is handled before churning to separate the butterfat. The study revealed that butter/ghee-making is an effective way to reduce losses when farmers cannot sell their milk. However, churning to separate butter fat is the most labor-intensive component of the overall ghee-making process; it is the bottle neck to increasing quantity without proportionately increasing the labor burden. Also, women handling large volumes complained of fatigue due to high energy required for manual churning. Women reported chest pains, especially those churning 10 liters of milk in 20-liter gourds. This posture of placing the gourd on their laps or between the legs on a cushion followed by shaking reportedly causes knee and elbow pains and as a result some women have given up churning. The study concluded that a hand-operated high capacity churning device, if developed and adopted, will not only increase farmer productivity in terms of reduced labor and/or increased incomes, but will also enhance quality and reduce churning-related health problems.

Key words: Smallholder, poverty, ghee, traditional processing, labor, fermentation, churning, productivity, Uganda

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INTRODUCTION

Uganda, with a total land area of 241,548 km^2, is divided into 111 districts. Approximately 75% of the land (over 18 million hectares) is available for both cultivation and pasture [1]. Agriculture is the backbone of the country's economy; the productive land covered by pastures used for dairy farming is approximately 1.8 million hectares [1]. Uganda is one of the largest milk producing nations in East Africa, accounting for 25% of the total milk supplied among other East African Community (EAC) countries (Kenya, Tanzania, Rwanda and Burundi) [2]. The country makes different dairy products including yogurt, Ultra High Temperature (long-life) milk and powdered milk, which are consumed within the EAC markets. Uganda has an operating dairy market built around a value chain that starts with rural producers (predominantly smallholder dairy farmers) and transporters or buyers. Most times transporters/buyers act as middlemen who deliver the milk to vendors and processors that sell to consumers in urban or peri-urban areas and process to high value products, respectively. Smallholder farmers may own between three to ten productive cows and may sell their milk through a private or communal collection/cooling/bulking facility (cooling center or CC, hereafter). Milk that fails to reach the market or the CC (especially the evening milk) or reaches but fails to meet quality standard is typically turned into butter that is clarified to produce ghee as a means of minimizing losses.

Most of the cattle in Uganda are found in the "cattle corridor" (see Fig. 1). Butter-making is predominantly done by women. It is estimated that such women who live in rural areas, work longer hours but their output (in terms of income) is always lower than that of men because of inadequate or no access to improved tools and processes [3], which indicates a need for intervention. To come up with female-friendly (ergonomically and culturally appropriate) tools that will reduce labor input and increase productivity, it is necessary to first understand the current labor-intensive practice and the tools used, if any. With respect to butter-making, the authors conducted a field study in the cattle corridor of Uganda to better understand current practices and they report the findings herein.

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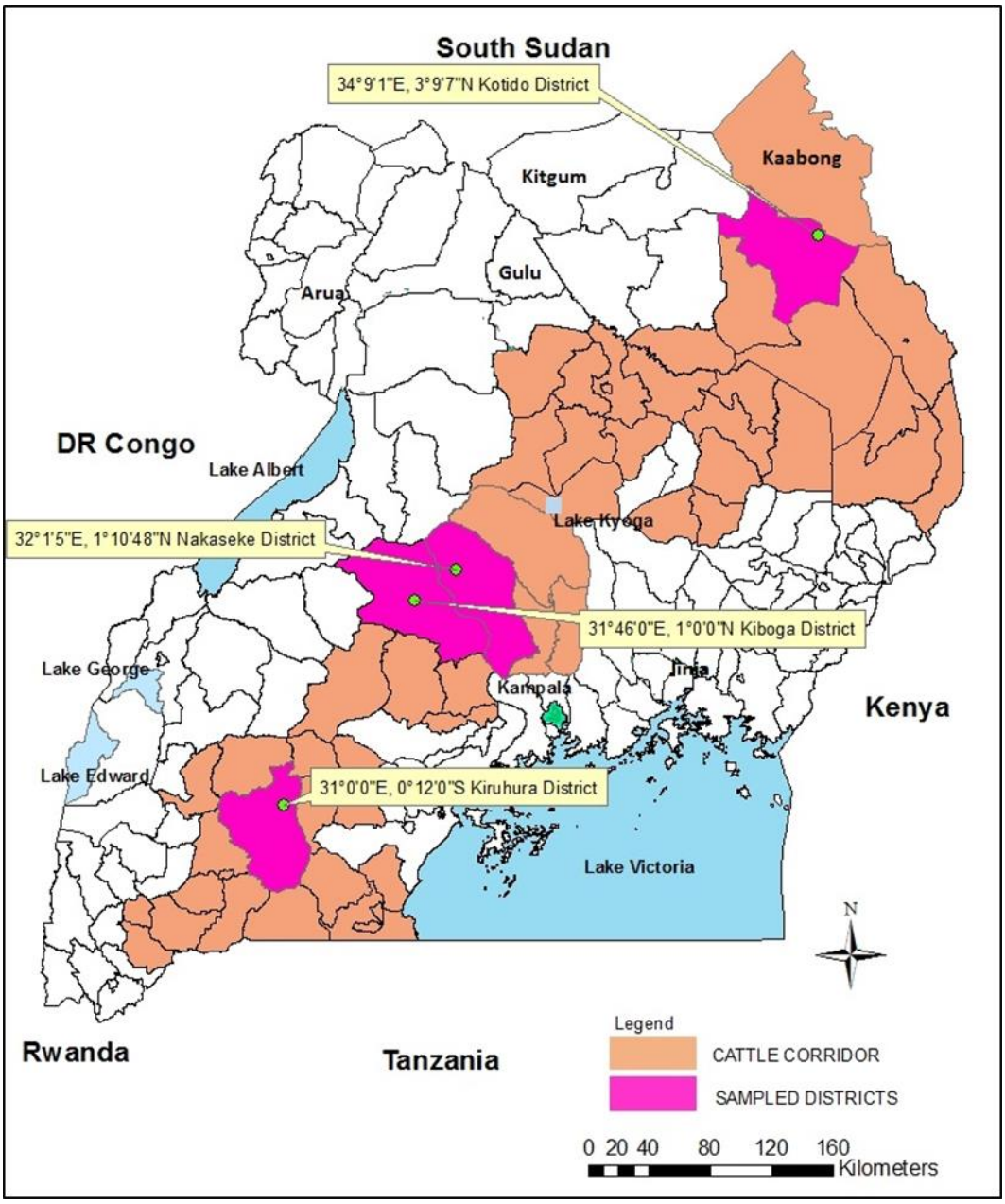

Figure 1: **Map of Uganda showing the cattle corridor (shaded). In the South and central districts, ghee is predominantly produced by the *Bahima/Bahororo* (Bantu) women. In the Northeastern districts, ghee is predominantly made by the *Bateso* and *Karamajog* (Nilotic) women**

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MATERIALS AND METHODS

Five study locations were randomly selected along the cattle corridor of Uganda based on two ethnic groups; Bantu and Nilotics. The study locations were: Ngoma village/town in Nakaseke district, Nyamilinga and Kabuye villages in Kiboga district, Kanyaryeru village in Kiruhura district and Kotido in Kotido district (see Fig. 1). At each of these locations, with the exception of Ngoma, the authors identified women who were already self-organized in a mission-driven activity. Two groups from Kiboga were *Abesiga Mukama* and *Ikamiro*. Both groups comprised of a total of 27 members and were engaged in value addition activities such as making butter, yoghurt and bulk (collecting milk from many members at a single point) milk marketing. In Kotido the group was *Etiyata Kapei*, comprised of 32 women engaged in local alcoholic beverage brewing and other agricultural activities. In Kiruhura the group was *Kanyaryeru* and it had a total of 13 members, whose main activity was also bulk butter marketing. All these women are self-driven with a motive of increasing incomes for members. The authors were not able to engage with similarly-structured women groups in Ngoma. This is because the initial contact assumed the role of a "technology broker" and as such access to the communities of the women was promised only when the technology was ready for wide dissemination.

The butter/ghee-making process was demonstrated by one or more members from each of the above groups. The production scale can be characterized as small for home consumption and/or for sale at a single household level. For groups like *Ikamiro, Abesiga Mukama, and Kanyaryeru,* the members pooled their butter/ghee to a single point of sale, turning the collective single household activity into a cottage butter/ghee-making activity. The authors took notes and video-recorded all the demonstrations. The women were further engaged in focus group discussions to better understand details of the process that might have been missed in the demonstrations, as well as challenges and opportunities.

RESULTS

Butter is made from the milk of a cow that has been lactating for at least one month. The milk and/or cream are allowed to ferment for up to 12 hours followed by churning in a gourd to separate the butter. The butter/ghee-making practices in the cattle corridor differ in how the milk is handled before churning to separate the butterfat. Churning is the process of shaking/mixing whole milk or cream to coagulate the fat into large chunks - forming butter. Butter refers to essentially the fat in the milk, usually made from the sweet cream. Butter is clarified by heating to reduce the moisture content and remove any contaminants to yield ghee. The current practices are outlined in Fig 2. The observations have been subdivided into pre-churning preparation, churning, and storage/preservation.

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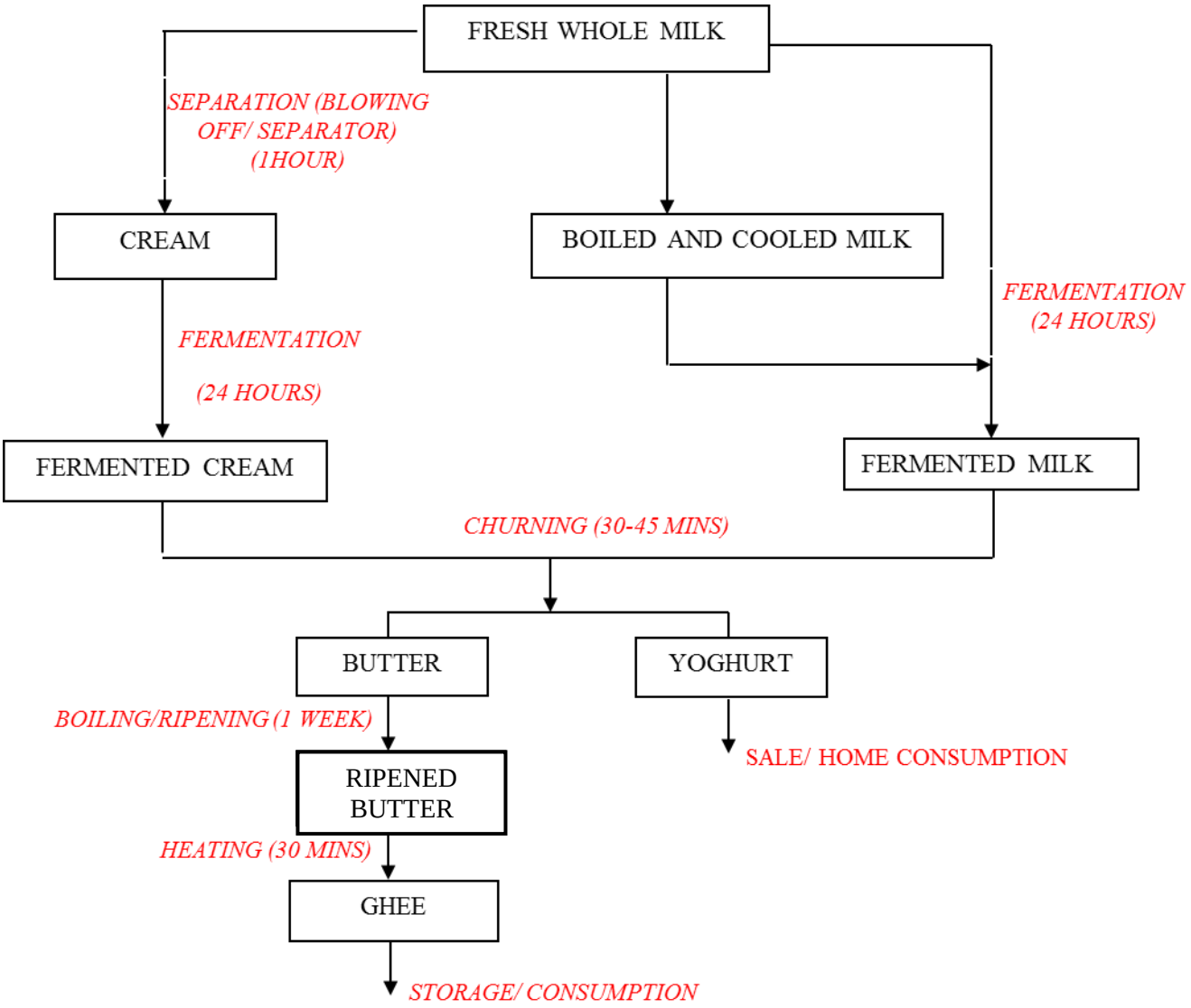

Figure 2: Schematic representation of the traditional ghee-making process in the cattle corridor. Regional differences are mainly in milk handling before churning. The practice shown on the left of the schematic is mainly found among the *Bahima/Bahororo* (Bantu cultures). The practice on the right is mainly found among the Nilotic cultures. The process takes approximately 1.5 weeks

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Pre-churning preparations

Traditionally, different cultures in the cattle corridor, for example, the Nilotic (*Jie*) and Bantu (*Bahima/Bahororo*) tribes use different tools to separate butter from the milk (Fig 3, A- B). The traditional tool used for churning is the gourd. Before churning, the fresh milk will go through stages of either boiling or separation, followed by seeding (addition of drops of yoghurt – *enkamyo (*local name from *Bahima/Bahororo* tribe), *ngakibuk (*local name from *Jie* tribe) to initiate fermentation. The addition of yoghurt quickens the fermentation process to a period of less than 12 hours. In some areas where butter making is done as a business, for example, in Ngoma, Nakaseke district, cream is first separated from the milk either using a milk separator or by the traditional way of blowing off (*okufuuwa;* See supplementary video clips 1 & 2, accessible at http://3pinnovations.uga.edu/Videos/Supplementaryvideoclip1.wmv and http://3pinnovations.uga.edu/Videos/Supplementaryvideoclip2.wmv, respectively). The process of blowing off involves separating the foam formed during milking and also the settled butter fat film that forms on unboiled milk stored at room temperature.

Churning

Churning is done mostly by women and girls. Based on tradition, social norms/customs and physiological characteristics in the different regions of the cattle corridor, women will always position themselves to postures that they find most comfortable for doing the churning (Fig 3. C-D). In the *Bahima/Bahororo* culture, the woman sits down with legs folded, shakes and rotates diligently the gourd on the base of soft materials or on her laps. In *Jie* Culture, the woman sits down with legs stretched, suspends the gourd on a string and oscillates it (See supplementary video clips 3 & 4, accessible at http://3pinnovations.uga.edu/Videos/Supplementaryvideoclip3.wmv and http://3pinnovations.uga.edu/Videos/Supplementaryvideoclip4.wmv, respectively).

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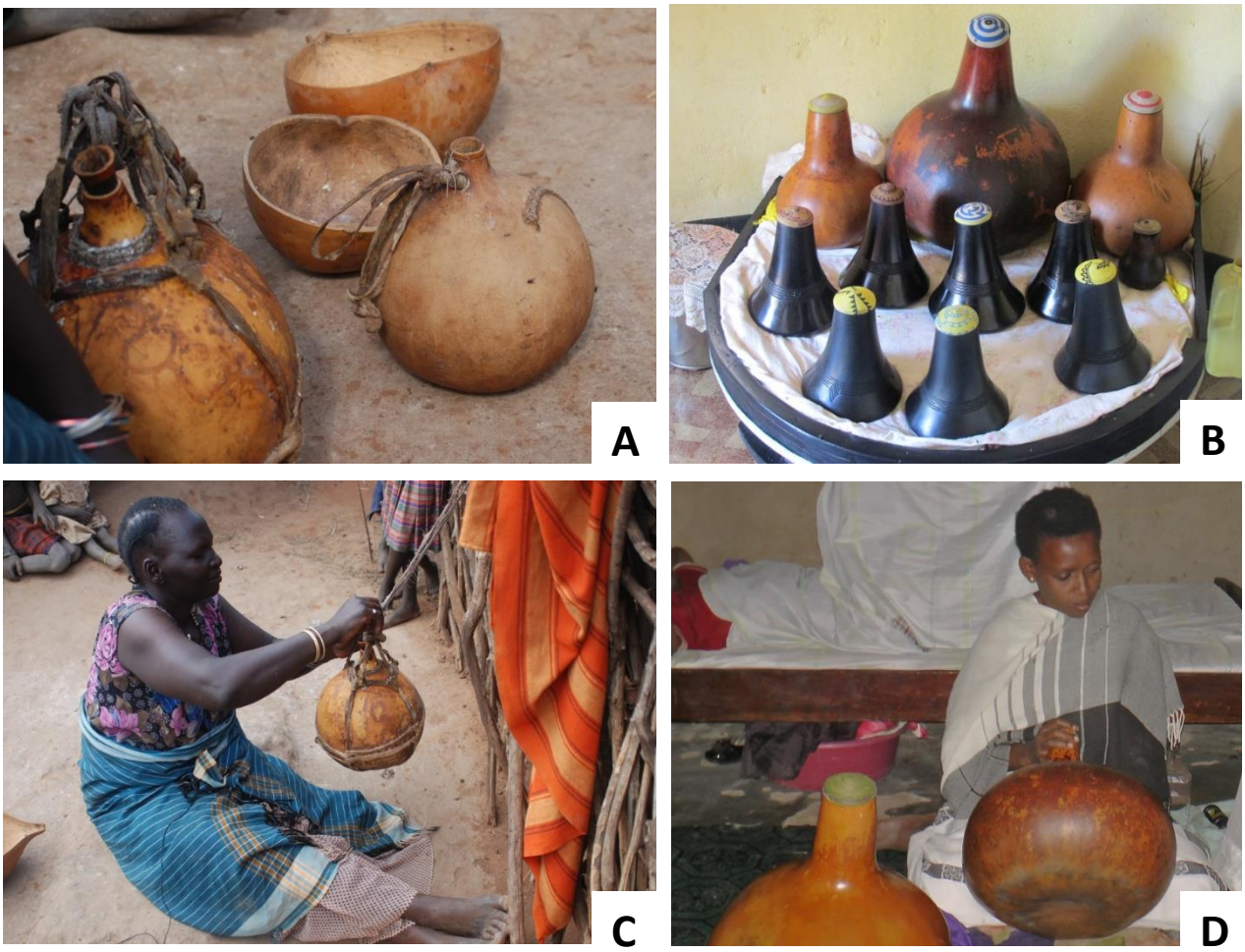

Figure 3: Tools used and postures when churning Milk in the cattle corridor: A). Tools in the *Jie* culture; calabashes, gourd; B). Tools in the *Bahima/Bahororo* culture; gourd, source pans; C). Churning in *Jie* culture: A woman sits with her legs stretched in front, ties the gourd on a hanging support and then shakes the gourd back and forth to produce the butter fat in the milk; D). Churning in *Bahima/Bahororo* culture: A woman sits down with her legs folded backward and places the gourd on a soft material, shakes the gourd back and forth to produce the butter fat in the milk

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Figure 4: Churning process: A) Vigorous shaking whilst removing the lid from the calabash to let out the pressure forming inside; B – D) Butter forms in the process and covers the surface with small droplets that finally coalesce; E – F) Removal of residual milk through a sieve from the gourd to separate butter that is washed with clean water before storage

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The butter formation process occurs in 3 phases and the process takes between 30-60 minutes depending on the speed, gourd size and milk quantity. The first 10 minutes (Phase 1), involves vigorous shaking whilst removing the lid on the gourd to let out the pressure that has formed inside (Fig. 4. A-C). For the subsequent phases, the woman keeps checking on the stage of butter formation as well as paying attention to the changing sounds in the gourd so as to accelerate or reduce the rate of shaking.

In Phase 2, shaking of the gourd needs to be slightly reduced. Butter forms in the process and covers the utensil surface with small droplets that finally coagulate to form bigger pieces. Phase 3 is associated with slower rotation of the gourd (see supplementary video clip 5, accessible at http://3pinnovations.uga.edu/Videos/Supplementaryvideoclip5.wmv) to allow the bigger pieces of butter fat to coagulate into single larger pieces, which enhances separation of butter from the milk residue (Fig 4. D – F). The milk residue (yoghurt) is poured out of the gourd through a sieve, separating it from the butter fat. Typically, 5 liters of milk is churned in a 10-liter volume guard. In less common situations, 10 liters of milk are churned in a 20-liter volume gourd. Due to mechanical shaking, the 20-liter gourds tend to break and are infrequently used.

Butter cleaning, turning into ghee and preservation/storage

The butter separated from the milk residue is washed to remove any dirt and any elements of residual milk. Washing involves rinsing small portions of butter at a time, with clean water while pressing in between palms to squeeze out any milk left. The butter is then stored to ripen for at least 1 week. Ripening involves keeping the butter to allow native microorganisms to mediate reactions that yield the desirable aroma and color in the butter fat [4]. In the past, ghee used to be kept in small calabashes called *ensimbo* by the *Bahima*. The calabashes were prepared to enhance the aroma of the butter. But most people today keep it in plastic buckets and cans especially farmers producing for both home consumption and sale. Butter can be heated or clarified to reduce water content. The shelf life for butter is about five months while that for ghee is about a year as reported by Mrs. Margaret Mukabashambo of Ngoma and Mrs. Jenifer Kataburingi of Kanyaryeru, who operate a point of ghee sale on behalf of their groups.

DISCUSSION

Ghee-market and uses

In Uganda, the following three types of butter are found in the market. 1) Industrially produced by different companies, for example, Sameer, GBK or imported from Kenya and South Africa. This type of butter can be accessed in mini/big supermarkets that are one stop shopping centers for middle class income earners. 2) Processed and branded butter by small scale producers found mini supermarket shelves. 3) Traditional butter sold out in open plastic containers sometimes as ghee to the locals at relatively lower prices.

Today, butter/ghee is enjoyed in many parts of Uganda and can be bought from local communities in Western Uganda, local markets in different parts of Uganda, and off the shelves of uptown supermarkets. The significance of ghee in pastoral communities is the

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renowned uses in sauce and as a spice [5]. This by-product of milk is the raw material for some popular meals in Western Uganda, such as *eshabwe* (light white-milky sauce). In addition, ghee is also enjoyed with other meals such as *katogo* (unmashed cooked green bananas), beans, and vegetables or as a replacement for cooking oil. In other parts of the world, like in India, families use ghee for hair dressing, as a skin cosmetic, and for medicinal purposes [6].

Ghee-making elsewhere in sub-Saharan Africa

Ghee-making was introduced to sub-Saharan Africa from India and Egypt. Indians have been known to make ghee from the fermented milk as far back as 1500 BC [5]. Different cattle-keeping communities in sub-Saharan Africa have engaged in ghee-making. This work also highlights the similarities and differences in butter/ghee-making in sub-Saharan countries derived from literature. This is because cattle-rearing communities in Kenya are traditionally similar to those in Uganda. For example, the butter/ghee-making methods by the *Masai* and *Kikuyu* tribes are very similar to those of the *Jie* tribe of Kotido [5].

In Ethiopia, butter/ghee-making is mostly done by the *Borana* tribe [5, 7]. Butter separation in these cattle keeping communities is similar to that in the cattle corridor of Uganda; however, tools and methods of preservation differ. The *Borana* use smoked *gorfa* (container woven from asparagus root fibers) or clay for fermentation and churning. The butter is then melted in clay pots using low heat. After most of moisture has evaporated followed by clarification, a handful of maize, sorghum or other cereals are added, together with some clean fresh grass and a pinch of salt. The ghee is then decanted and kept in a container with a tight lid and stored for one to three years before it spoils. In Sudan, ghee traditionally is referred to as *Samin*, also known as *Dihin* or *Dihn*, is made by the heat clarification of butter called *fursa* or *zibda* [5]. Butter separation from milk residues is also similar to the methods observed in Kiboga, Ngoma and Kanyaryeru villages. However, the process of conversion of butter into ghee is similar to that used by the *Borana* tribe of Ethiopia. This is characterized by heating butter after churning and small pieces of dough made from sorghum or millet added to help clarify the product.

In Namibia, ghee (locally known as *omaze uozongombe*) is made in most regions, especially by the *Herero* tribe [8]. The traditional churning process is the same as that observed in the cattle-keeping communities of Uganda. In Botswana, butter/ghee-making process is different from that in the cattle corridor of Uganda and other sub-Saharan countries. *Madila* is the traditional name for fermented milk in Botswana [9]. The traditional churning process takes between 10 and 15 days which is quite a long process. Fermented milk is prepared by filtering fresh milk through a strainer and then placed in an enamel bucket. This is then kept in a warm place for 24 hours to initiate fermentation. The soured milk is then poured into a woven polypropylene sack to which a bucket of one-day old soured milk is added each day over a seven or eight-day period. The bag is then hung from a beam for three or four days during which time the milk whey drains away through the woven bag. Finally, the fermented milk is removed from the bag and churned to form butter.

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Challenges and opportunities

Churning to separate butter from the milk is a role performed by women not only in the cattle corridor, but in other sub-Saharan countries as well. The groups of women observed in the cattle corridor of Uganda unanimously pointed out that in addition to their daily domestic/house work, they find the whole ghee-making process tiresome, laborious and time consuming. They welcomed any labor-saving tool, if available. As written below, the authors further explored the challenges and opportunities based on field observations and/or responses obtained from women.

During the seeding of milk, women do not know the exact amount of starter (yoghurt) to be added to the fresh milk required for fermentation and for how long to wait before churning. Some women indicated 2-5 starter "drops". Guidelines for a more exact starter may be useful. For most smallholder dairy farmers, electric- or hand-operated separators are too expensive; 3-4 and 5-6 million Ugandan Shillings (UGX) for hand- and electrically-operated separators, respectively. In scenarios where electric cream-separators are used, ghee-makers face a problem of unreliable power supply. Among the groups engaged, some have used gasoline-powered generators, but the fumes from these generators contaminate the resulting ghee – reported to harbor fuel exhaust odors. Because ghee-buyers are sensitive to its smell, gasoline fumes-contaminated ghee has little or no market value.

The women groups making ghee as a way of increasing their incomes expressed a desire to establish reliable buyers of their product. Middlemen tend to offer very low-prices discouraging ghee-making in some of these communities. Yet, according to the unit economics analysis (in the following Section), ghee-making by these smallholder women farmers should be a profitable venture. It may be beneficial for these women groups from different regions to organize and bring their product to markets in urban centers. It will be even more beneficial if they can process and package their products to gain entry in the supermarkets where higher-end consumers are likely to spend a premium for the traditional taste these products offer over the industrially produced counterparts.

The traditional churning of fermented milk/cream to produce butter, observed is laborious. Women handling large volumes complain of fatigue due to the large amount of energy expended during manual churning. Women who performed manual milk churning have reported chest pains, especially those that used the 20-liter gourds. As previously described (Fig 3D), women place the gourd on their laps or between the legs on a cushion and then shake. This posture reportedly causes knee and elbow pains and as a result, some women have given up on performing milk churning. Those that still perform milk churning have been known to experience pain, which keeps them away from other household works such as cultivation, fetching water, and preparing food. This results in extra expense to hire workers to help with ghee-making. Parents in Kotido have a practice of keeping children away from school so as to provide labor for manual churning. A manual labor-saving device or tool would not only improve women's wellbeing, but would also free children to attend school. In contrast to the practice in Kotido, farmers in Mbarara and Ngoma do not boil their milk before churning. This renders the consumers of raw butter called e*shabwe* vulnerable to brucella disease, should an outbreak occur. The women in Kotido have been sensitized on this issue by the

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government and other organizations. The authors observed use of soap at several locations during cleaning of butter after churning, reportedly to avoid butter sticking to women hands. It is possible soap residues end-up in the butter/ghee that is marketed.

Differences in ghee/butter production processes were observed. Yet despite these differences, farmers seem to produce ghee with similar desired taste and aroma the consumers like. It is possible the critical "harmonizing" stage for developing these characteristics is the ripening stage.

Unit economics

This work has identified three types of smallholder farmers for whom the following outline of the economics of ghee-making operation applies. Farmer 1, sells her milk directly to consumers and/or collection/cooling/bulking (CC) centers (she is close to urban markets). Farmer 2, separates cream for butter/ghee-making and sells the skimmed milk to a milk CC center at a reduced price. Farmer 3, ferments all the milk to produce butter from which she makes ghee for sale (she may sell her morning milk like Farmer 1, but cannot sell the evening milk because of long distance from markets and lacks means of keeping it fresh till the next day). In Ngoma, the authors observed a unique ghee-maker (Mr. Kabendera), who operates a CC center that buys from the likes of Farmers 1 and 2. He buys the milk that is brought to the CC center which does not meet required specification (for example, freshness and water content) at a reduced price, reducing the farmer's loss. He uses an electric/gasoline-powered separator to separate the cream and makes butter/ghee the traditional way in quantities larger than the typical smallholder farmer. To handle the larger butter/ghee volume, he hires several women to do the churning.

From the Ngoma market, the unit cost (1 liter) of milk ranges between 600 and 800 UGX depending on the season (rainy versus dry). The authors assumed the average of 700 UGX for the analysis. On average, 1 kg of butter is produced from 20 liters of milk and this kilogram sells for 12,000 UGX. Additional assumptions include labor cost of 20,000 UGX per week, supported by field observations. The authors propose a female-friendly (culturally and ergonomically appropriate) churner, a modified form of a previously published version [10] with a projected capital investment of 500,000 UGX for a 20- to 40-liter capacity. The churner retail price is based on a manufactured batch of at least 500 units. The authors also assumed a smallholder farmer milk production of 20 liters per day. A simple comparison of income among the three farmers (Farmers 1, 2 and 3) is presented in Table 1. It should be pointed out that other inputs to produce the 20 liters/per day have not been factored into the calculations – they have been assumed to be the same for each of the farmers, which is a reasonable assumption. As shown in Table 1, the woman who separates cream and manages to sell the rest of the milk (Farmer 2) obtains the most value out of her milk. It is probably because of this economic advantage that the simple cream separation practice (for example, blowing) is spreading. Such separation methods leave a large fraction of the cream in the milk. The milk, especially from local breeds with high butterfat content, fetches full value (for example, between 600 and 800 UGX) from the CC. The value of the introduction of the labor-reducing churner can be indirectly realized in several ways. First, there may be no need to hire laborers, because the smallholder farmer may do the churning herself. The possibility to

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handle higher volumes at the same time may free the smallholder farmer to do other income-related activities or other general household chores.

CONCLUSION

The results from this survey support the following conclusions: 1) Ghee-making is a meaningful way to reduce losses when farmers cannot sell their milk; 2) Churning is the most labor-intensive of all the components of the butter/ghee-making process; and 3) A churning-labor saving device may not only increase rural dairy farmer productivity, but may also provide higher quality ghee and reduce churning-related health problems.

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All procedures performed in this study involving human participants were in accordance with the ethical standards of the University of Georgia Institutional Review Board (STUDY00001461) and the Uganda National Council for Science and Technology (SS 3422).

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Tables 1: Unit (20 liters/day) economic analysis, based on seven day-period (week) of butter/ghee-making with the proposed mechanical churner

	Income from milk (UGX)	**Income from ghee (UGX)**	**Total income from 20 liters of milk (UGX)**	**No. of workers**	**Labor costs per week (UGX)**	**Income (UGX)**	**Churner payback period (weeks)#**
Farmer 1*	14,000 *x* 7 days = 98,000	-	98,000	-	-	98,000	5.1
Farmer 2	14,000 *x* 7 days = 98,000	12,000 *x* 7 kg = 84,000	182,000	2	40,000	142,000	3.5
Farmer 3	-	12,000 *x* 7 kg = 84,000	84,000	2	40,000	44,000	11.4

***** *Farmer 1 - sells her milk directly to consumers and/or collection/cooling centers; Farmer 2 - separates cream for butter/ghee-making and sells the skimmed milk to a milk collection/cooling center at a reduced price; Framer 3 - ferments all the milk to produce butter from which she makes ghee for sale.*
 # To calculate payback period, the authors divide churner capital investment (500,000UGX) by weekly income
UGX-Ugandan Shillings

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