PROPOSED DIRECT USE OF GEOTHERMAL RESOURCES IN ABATTOIRS: CASE STUDY OF BARINGO, KENYA

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ABSTRACT

Most of the livestock in Kenya are reared in arid and semi-arid lands (ASALs), where geothermal resources are abundant and the North Rift is one of these regions. The inhabitants are majorly pastoralists with several herds of livestock but they earn low incomes due to the poor value chain available at their disposal. A modern slaughterhouse complex with chillers is proposed for this region. The temperature requirements for the abattoir processes range from 30°C to 120°C of which GDC will be able to avail in addition to the electrical energy. GDC, due to the massive resources available in the North Rift, will be able to supply water for the proposed capacity of 1000 livestock per day bearing in mind the health standards of 1500 litres per cow and 500 litres per sheep/goat. This report details the enormous benefits from such a facility that utilizes geothermal resources to run its processes.

1.0 INTRODUCTION

The livestock sector contributes about 12% of Kenya's Gross Domestic Product (GDP), 40% to the agricultural GDP and employs 50% of agricultural labour force. About 60% of Kenya's livestock herd is found in the arid and semi-arid lands (ASALs), which constitute about 80% of the country (RoK, 2014). Beef farming is very important in Kenya today. Ninety per cent of beef cattle in Kenya are in the hands of subsistence farmers and pastoralists. The distribution of beef cattle in Kenya is influenced by rainfall patterns. Small-scale beef farming is carried out in almost all parts of Kenya. Most of the livestock in Kenya are reared in arid and semi-arid lands (ASALs), where some 90% of employment opportunities and 95% of family incomes are derived from the livestock economy (USAID, 2012).The hides, skins and leather industry are estimated to earn about 4% to the Annual GDP and employs about 10,000 individuals in the informal and formal sector. The development of functioning livestock markets is the long-term and permanent solution to successful and efficient emergency livestock off-take (Nyariki, et. al, 2005). Higher returns can be achieved if all these processes are undertaken in a modern and efficient way

1.1 Livestock production in Baringo County

Currently, Baringo County has 348,890 beef cattle, 344,331 sheep and 859,640 goats for meat production as shown in Table 1. Baringo is one of the ASAL counties and drought seasons are normally experienced. During such incidences, livestock management is a big challenge due to insufficient water and pasture. There are more goats than sheep and cattle due to ability of the former to tolerate dry conditions.

Table 1: Meat Livestock Production in Baringo County

Sub-County	Beef cattle	Sheep (mutton)	Goats (chevon)
Baringo Central	13,092	11,880	27,745
Baringo North	30,458	41,334	164,718
Mogotio	106,991	113,915	168,407
Marigat	60,400	65,600	168,870
East Pokot	122,342	77,455	312,438
Koibatek	15,607	34,147	17,462
	348,890	**344,331**	**859,640**

Source: County Director of Livestock, Baringo

Literature shows that pastoralists in the county are generally reluctant to sell their livestock during the wet season when pastures and water are readily available and animals are in good body condition. Pastoralists normally respond to drought by moving livestock to dry season grazing areas, migrating with their livestock to neighbouring regions in search of pasture and water, and also by selling. It has been noted that market outlets for livestock are inadequate and cannot absorb the large volumes offered for sale during drought. Furthermore, pastoralists realize depressed prices from the sale of their livestock during drought as a result of large supply and poor animal condition. During severe drought, the livestock owners lose large numbers of livestock, resulting in an economic loss to the individuals and the national economy as whole (Nyariki, et. al, 2005)

2.0 GEOTHERMAL DIRECT USES IN ABATTOIR PROCESSES

Baringo has massive potential of geothermal energy and Geothermal Development Company (GDC) has mapped out five prospects areas in the county. These prospects areas are: Arus-Bogoria, L. Baringo, Korosi, Paka and Silali. The temperature requirements for the abattoir processes range from 30°C to 120°C of which GDC will be able to avail in addition to the electrical energy. Water required during all abattoir processes will also be supplied from the steam condensate and the separated brine. The direct heat from geothermal fluid can be used to heat water for use in abattoirs and also though absorption cooling, to provide chilling.

2.1 Status of livestock processing in Baringo County

Inhabitants of the county prefer meat from small stock (goats and sheep) to meat from bovines (cattle). This explains why fewer cattle were slaughtered in in the year 2013 than a combination of sheep and goats i.e. 9618 cattle, 45343 sheep and 13422 goats. These figures do not express the actual statistics because livestock slaughtered and consumed within households are not always captured. This implies that the slaughter figures in Baringo county are higher than the ones recorded by livestock production officials. These officials obtain their figures from slabs and slaughter houses within the county.

Table 2: Slaughter figures for Baringo County

Species	2010	2011	2012	2013
Cattle	10979	11148	10983	9618
Sheep	61250	46531	59496	45343
Goats	10526	10185	12610	13422

Source: County Director of Livestock, Baringo

Currently there are 11 slabs and slaughterhouses in the county. Carcasses from the slaughterhouses in Baringo are sold to local butcheries where locals buy meat for consumption. Hides and skins

from these slabs and slaughterhouses are sold in raw state. The end market for hides and skins from this county is mostly found in Nairobi.

2.1.1 Proposed slaughterhouse

Baringo County is vast and has a potential to increase livestock numbers beyond the current level. The county government also has plans of establishing feedlots in Loruk area in East Pokot Sub County in order to boost quality of beef cattle pasture establishment and plan is in place to facilitate this course. The feed lots once implemented will lead to increased production of livestock and hence the need for abattoir processing plant. This will offer ready market to pastoralists, create employment for the local people and thus providing alternative source of income. An abattoir processing facility with a capacity of 1000 heads of livestock is quite sufficient to accommodate all the projected supply from the county. The main hygiene principle in slaughterhouses is that clean and unclean operations are efficiently separated. This requires a well-planned plant layout, where the purpose of any structure should be to protect the products against unintended contamination (figure1).

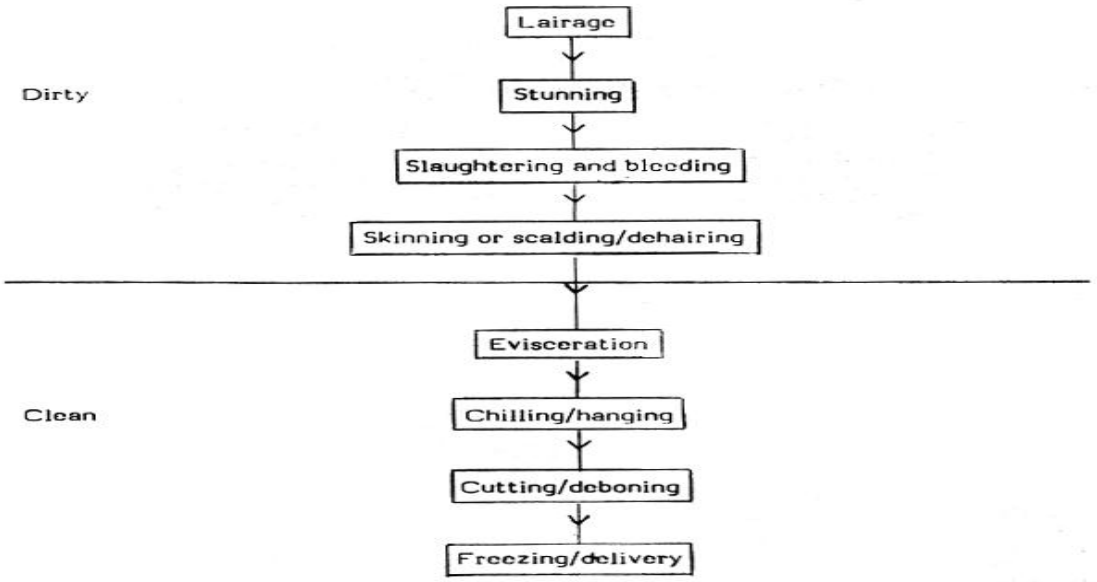

Figure 1: Flow-diagram showing the principles in a slaughtering process (FAO, 2014)

2.2 Energy and water requirements for the proposed slaughterhouse

A medium slaughter house is proposed, with a capacity of about 1000 heads of livestock per day, i.e. 400 cattle, and 600 goats and sheep. The facility will require three (3) acre space in order to accommodate buildings, holding pens, effluent disposal ponds, off loading zones and subsequent abattoir complex.

2.2.1 Energy requirements

Both electrical and thermal energy are required. Electricity will be required for lighting and operation of electrical components such as pumps and motors. The thermal energy would be used for cleaning, pre-cooking and sterilisation. The temperature requirements for the abattoir processes range from 30°C to 120°C and this can be supplied from the geothermal brine through the use of heat exchangers.

The geothermal brine at a temperature of about 150°C will heat cold fresh water to about 100°C. The heated fresh water will then be used for all the applications. Hot brine can also be used directly for cleaning of the floor and drainage.

Cold chain is a continuum from the time the carcass is skinned and eviscerated and enters the chilling processes. This helps to get rid of a level at which microorganisms grow i.e., bacteria occurs between 10 and 50°C. Carcass should therefore be conveyed to the cooler within 40 to 45 minutes after slaughter. If cold chain control is violated at any point, meat safety, quality and hygiene will be compromised. Rapid cooling of the meat surface not only slows and nearly stops the development of surface micro -organisms but also reduces weight loss and discoloration of the surface owing to haemoglobin oxidation. The chilling facilities shall be able to bring down the core temperature of the carcass down to between 0°C and 5 °C within 24 hours after slaughter. The carcasses are held at these temperatures for 5 - 7 days to age the meat resulting to tender juicy meat cuts. When the preservation period is longer than that acceptable for chilled meat, freezing must be used to minimize any physical, biochemical and microbiological changes affecting quality of meat in storage. The freezing temperature should be in the range of -18° to -25°C for periods of preservation of one year or more (GoE, 2009)

Table 3: Practical storage life of meat and meat products

Products	Practical storage life in months		
	-18 °C	-25 °C	-30 °C
Beef carcass	12	18	24
Lamb carcass	9	12	24

Source: (GoE, 2009)

Cold storage of beef can be achieved by the use of absorption chillers. These utilise hot geothermal water as the source of energy, and mixture of water and ammonia as the working fluid (Colibri-bv, 2004). Baringo geothermal prospects have inferred reservoir temperatures of over 200°C (medium to high temperatures). This implies that all abattoir processes can be adequately powered (Figure 2).

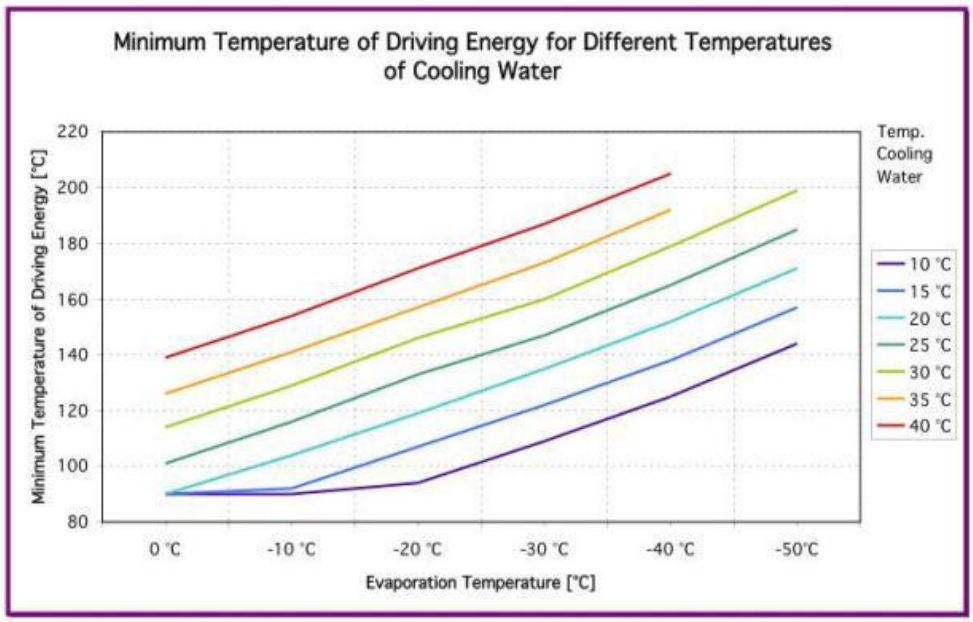

Figure 2: Hot water and evaporation temperature for different temperatures of cooling water (Colibri-bv, 2004)

2.2.2 Water requirements

The proposed abattor, with a capacity of about 1000 livestock per day bearing in mind the health standards of 1500 litres per cow and 500 litres per sheep/goat requites. Figures in table 4 illustrate water requirements at slaughter houses. Sufficient water is required for drinking, washing animals, cleaning holding pens and slaughterhouse, cleaning carcasses in a way which assures hygienic products.

Table 4: Water Requirements for the proposed slaughterhouse

Type of animal slaughtered	No of animals slaughtered/day	Water required for per head(litres)	Water required per day (Litres)	Water required per year(litres)
Cattle	400	1500	600,000.00	180,000,000.00
Goat/sheep	600	500	300,000.00	90,000,000.00
Total	**1000**		**900,000.00**	**270,000,000.00**

Source: Kenya Meat Commission (KMC, 2013)

In the holding pens, where animals are hosted after being off-loaded from trucks, water and feed troughs should be cleaned and sanitized on a routine basis. Potable water should be sufficient. In addition, a spraying system where the animals can be cleaned before entering the slaughterhouse is recommended, and this exercise consumes a substantial amount of water. Carcass washing process should be thorough to remove incidental contamination such as blood clots, dust and hair.

3.0 OTHER CAPTIVE INDUSTRIES

During the slaughtering process, several by-products are generated which are partly collected and partly disposed of. These by-products are: hides and skins, blood, hides and skins, offals, bones and horns. Due to availability of geothermal resources and by-products from the proposed slaughter house, complementary industries which may emerge.

3.1.1 Leather industries

Wet salting, is a kind of curing where salt has absorb so much moisture that decomposition cannot set in (Karuri, 2007). With more research, geothermal waters can be utilized for this purpose due to availability of salts forming it. After treatment, a lot of energy and water are required when tanning hides and skins for use in leather industry. Value addition in leather industry helps the economy to generate more income since final products like shoes and bags are of higher value than raw hides and skins.

3.1.2 Feed processing industries

Blood can be mixed with cereal products, such as bran, and then dried to enrich animal feeds. This helps to convert the low protein vegetable matter to a first-class animal protein. This process requires heat, first to sterilize blood under pressure and then to dry the mixture. Bones from livestock slaughterhouses can be used to make animal feeds. This animal feed contains calcium and phosphorus which are important supplements for livestock.

3.1.3 Soap, glue and oil industries

When animals are slaughtered, two kinds of fats are obtained i.e., edible (around the intestines) and non-edible (from bones). Separation is done during processing then fats are packaged in readiness for use in other industries. Inedible fats are used in manufacturing soaps for the while the edible fats are used for processing of cooking oils (Karuri, 2007). Bones also have organic component called ossein which can be utilized by industrialists in manufacture of glue.

3.1.4 Fertilizer processing plants

The proposed Slaughterhouse will generate a lot of waste especially from offal (internal organs). Slaughterhouse wastes can be utilized by fertilizer manufacturers as cheap additives to their production lines.

3.1.5 Home Décor and Ornamental industries

Horns and hooves can therefore be used for items such as making ornaments, buttons, home display and decorations.

4.0 CONCLUSIONS AND RECOMMENDATIONS

Kenya's North Rift Region has huge potential for geothermal resources and this can adequately support the proposed slaughter house with a capacity of about 1000 heads comprising 400 cattle, and 600 small stock (sheep and goat). With the ongoing plans by Baringo County to establish feed lots at Loruk area, livestock production is projected to increase thus the need for a consistent market.

A geothermal operated abattoir is therefore ideal in this area since it will create a demand pull for sustainable production of livestock. Communities surrounding the slaughter house will benefit from employment opportunities available from livestock production, slaughterhouse processes and marketing of slaughterhouse products. Other captive industries will include leather tanning, animal feed plant, soap, glue and oil industries, fertilizer making plant, and other cottage industries.

More studies need to be done on processing of other abattoir by-products using geothermal resources. The potential of North Rift geothermal prospects is can enable complete value addition in the livestock industry. This can therefore lead to more revenue, employment opportunities available to the local community and improved national economy.

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