Proceedings 5th African Rift Geothermal Conference
Arusha, Tanzania, 29-31 October 2014

Livestock, Herders and Steam: Geothermal Energy Technology and its Application in Sustainable Pastoralism in the Arid and Semi-Arid Lands of Kenya.

Lomeri C. P., and Rotich, B.

Geothermal Development Company

P.O. Box 100746-00101 Nairobi, KENYA

plomeri@gdc.co.ke[1], brotich@gdc.co.ke[2]

Keywords: Transhumance, Sustainable pastoralism, Rendering

ABSTRACT

Most geothermal prospects in Kenya are spread along the arid lowlands on the floor of the Rift Valley. The expansive area stretches from Magadi in the south to Barrier in the southernmost tip of Lake Turkana in the north of Kenya. The said areas are inhabited by pastoralist communities who have lived on the plains for ages tending livestock and have co-existed within the fragile ecosystem characterized by drought, famine, perennial high temperatures, and catastrophe of encroaching desertification and global warming. The floor of Rift Valley is dotted by a series of hills with volcanic activity and geothermal manifestations. The hills have been used by the herding communities as pasture reserves for use during the dry spells when the lowlands' pasture is depleted. The hills also served as strategic safe haven during wars and are believed to be home to deities. Traditional livestock rearing practices have been facing a multitude of challenges over the years. Albeit the interventions and innovations that pastoralists' have put in place in a bid to mitigate the dangers that render pastoralism near-extinct, much needs to be done by carrying out extensive research, developing preventive strategies, building peace, improving security and maximizing direct commercial returns from livestock. However, innovation will play a pivotal role in making livestock-keeping a sustainable venture. Such innovation may include employing alternative geothermal uses in improving livestock production, given that geothermal exploitation will take place within the home to the herding communities. Thus this paper aims to diagnose major challenges facing pastoralism in Kenya and further prescribe possible interventions and practical applications in containing the challenges facing pastoralism through innovative utilization of geothermal technology.

1. INTRODUCTION

Pastoralists are people who depend on livestock and livestock products for most of their income and consumption. Majority of pastoralists graze their animals on communally-managed or open-access pastures. They have the propensity to move seasonally with their livestock. According to several international bodies, the number of pastoralists in the world today is estimated to be 260 million. Extensive pastoral production is practiced on 25% of the global land area in 40 countries from the horn of Africa, the Sahel, the Middle East, South and Central Asia, Mongolia, China among other places. Africa is home to about 60 million pastoralists, with about seven million of them living in Kenya.

According to Massarenti (2012), pastoralists comprise a minority in their countries, occupy marginal land along national borders, and - except for few notable countries such as Somalia and Mongolia – are ruled by political elite often representing an agricultural majority who live in higher rainfall zones. Paradoxically, countries with large pastoralist populations are among the poorest in the world even though pastoralists own herds that are very large absolute terms and very significant to the national economies.

In Kenya, pastoralism contributes to about 12 per cent to the Gross Domestic Product, which comprise 42% of total agriculture GDP. Pastoralism provides 90 per cent of employment to Kenyans living in Arid and Semi-Arid (ASAL) areas; which constitutes 95 percent income-earner for the ASAL population. *Food Sovereignty Brief* indicates that livestock raised by pastoralists in Kenya accounts for 800million US dollars per year.

Research has shown that livestock reared in pastoral systems contribute significantly to national and regional economies through dairy, meat, skin and fiber production; use of animals for transport and ploughing, use of manure as fertilizer and fuel; livestock insurance and tourism. Pastoralism also contributes important environmental services such as carbon sequestration and biodiversity conservation.

However, the pastoralist communities have become increasingly vulnerable to myriad crises: floods, drought, famine, rapid population expansion, climate change, political unrests as well as inappropriate government policies and practice. Pastoralists have been rendered vulnerable as a result of respective governments formulating policies that are neither consistent with the needs of pastoralists nor responsive to the uniqueness of the pastoral system.

Pastoralism is more often seen through an eye of critical aspects such as mobility and reliance on indigenous knowledge that are treated as backward and inconsistent with the imperatives of a modern state and contemporary economy.

Considering pastoralist's significant contribution to the world's economy; it being a source of income for over 200 million households worldwide and practiced on over 20 percent of landmass, it would be noble to address and reduce pastoralists' vulnerability – through applying geothermal technology - in order to attain sustainable pastoralism.

2. SUSTAINABLE PASTORALISM

Sustainable pastoralism refers to continued development of pastoralists' activities as economically viable and valid means of production that meets the needs of the present without compromising the ability of future generations to earn from the practice. For pastoralism to be sustained, a multi-faceted approach should be embraced so as to institute pragmatic livelihood support which in return will promote holistic development of pastoralist areas and reduce vulnerability.

This paper centers on pastoralists communities found in the northern parts of Baringo County, Kenya. These pastoralists inhabit Arid and Semi-Arid Plains of Tiyati Sub County within the proximity of Silale, Paka, Chepchuk and Korosi geothermal prospects. The paper further explores possible avenues through which the pastoralists may utilize and benefit from both direct uses of geothermal energy and other alternative uses of geothermal resources.

Sustainability in pastoralism can be attained through prudent application of geothermal resources. It is evident that electricity generated from geothermal source can transform the pastoralists' lives by enhancing their capabilities in cottage industries, education, communication and trade. This piece of work will purposefully sidetrack from direct use of geothermal energy and delve into other innovative and proven application of direct use of geothermal resources. Below are practical solutions that may be put into practice so as to enhance livestock production, inject diversity in herders' modes of production, mitigate climate challenges and at the same time supplement livestock dependency:

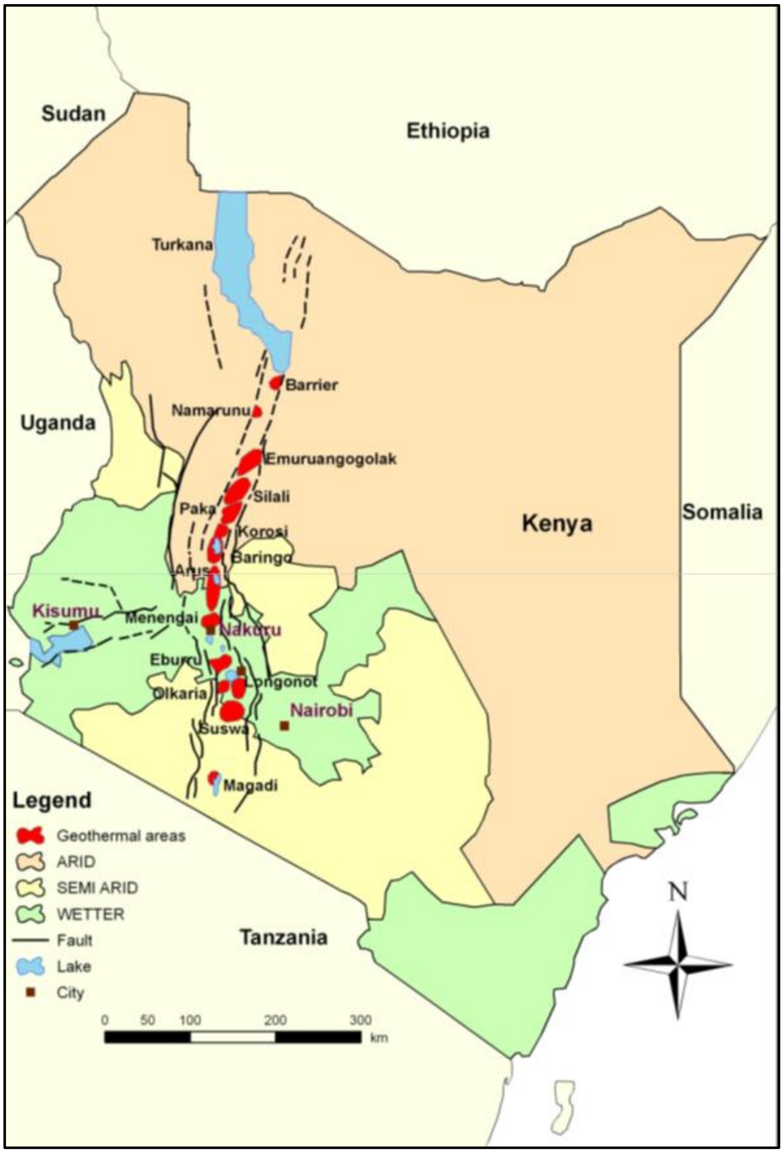

Fig. 1: Correlation between aridity and geothermal prospects in Kenya (Source: Ogola 2010).

2.1 Use of Geothermal Heat Energy for Meat Processing and Storage

2.1.1 Use of Geothermal Heat in Rendering

Rendering is a heating process in meat-industry waste products through which fats are separated from water and protein residues for the production of edible lards, tallow and dried protein residues.

During rendering, the material may be processed wet or dry. Wet processing, on one hand, involves adding boiling water or steam to the material causing fat to rise to the surface before it is separated. On the other hand, dry processing involves releasing fat by dehydrating the raw material.

Rendering end-products include meal meat, meat-cum-bone meal, bone meal and fat from animal tissues. Edible products produced from rendering are lard, tallow and greaves. Separated fat may also be used for soap making. Tinned cat and dog food is an edible material rendered using alternate process. Dried bone meal is a major product of rendered inedible products.

2.1.2 Extraction of CO_2 for Chilling Abattoir Products:

Carbon dioxide (CO_2) is one of by products from geothermal system and can be extracted for use in chilling abattoir products. CO_2 is used as a key cryogenic agent in cooling, chilling and freezing applications. It aids in protecting the taste and texture of preserved food by maintaining proper temperature control. While processing food, the heat generated during mixing and grinding accelerates bacterial growth that in turn can lead to off-flavors, decreased shelf-life and spoilage. Cryogenic mixer cooling assures uniformity of temperature which is essential in obtaining accurate and consistent results with patties and formed products. Properly chilled meat and pork ensures the perfect incorporation of fats without smearing. It helps chilled meat retain its flavor, quality and texture. At Kizi Idere geothermal field in Turkey, 120,000 tonnes of liquid CO_2 and dry ice is produced from geothermal fluid annually (Lund, et.al, 2005). Carbon dioxide can also be used in green house growing and beverage carbonation.

2.1.3 Use of Geothermal Energy in Processing Animal By-Products

Geothermal steam can further be used in processing of animal by-products. Establishment of abattoirs should not capitalize on meat processing alone but should also venture into processing of meat industry waste products. These waste products, according to Kumar (undated) include: hides, skins, blood, bones, hooves, and offals.

Processing of animal by-products will ensure that slaughterhouses emissions are well managed. Management of slaughterhouses solid and wastewater has become an environmental problem within slaughterhouses areas. Solid waste from slaughterhouses and meat processing industry include: inedible offal, rumen contents, paunch and stockyard manure. All solid waste has a potential use as fertilizer. Slaughterhouses effluents too constitute a critical environmental pollution and health hazards in almost all developing countries. The wastewater constitutes remnants from intestines de-sliming and casing washing, blood and paunch.

Of all waste products, blood and paunch have the highest polluting values. When completely sewered, they lead to a total waste load of 10kg and 2.5 BOD per ton of LWK respectively. Where LWK refers to the weight of the carcass expressed as a dressing percentage (carcass weight/live weight*100) Thus Geothermal energy can be used to dry blood and paunch. Dried blood and paunch is a key ingredient in making fertilizer.

In addition, food processing industry can benefit more from geothermal energy since steam can be used in sterilizing equipment and rooms without using necessarily drugs or chemical.

2.1.4 Use of Geothermal Heat Energy in Milk Processing

The pastoralists around the world contribute up to –percent of milk annually. In Kenya milk processing is restricted in high rainfall regions and urban areas. Millions of liters of milk produced by herders are consumed raw (unprocessed) thus pastoralists do not realize meaningful gains from milk. Geothermal energy can be used in the processing of pasteurized, UHT, condensed, powdered and evaporated milk. For instance, a low to medium temperature geothermal resource of between 65-85°C is well suited for production of natural-tasting powdered milk (Bibek 2001). Bogoria-Silale geothermal prospects have potential to supply thermal energy for milk pasteurization and further processing. Through absorption cooling, heat from geothermal fluids can create chilling temperatures for milk cooling.

Diversifying livestock to include drought-tolerant milk animals may be considered to boost the volume of milk produced. Particular efforts may be directed to highly nutritious goat's milk and medicinal camel's milk.

2.2 Use of Geothermal Waters in Livestock Treatment

Traditional animal husbandry practices related to utilization of geothermal resources include the use of geothermal waters for treatment of skin infections among other vector-borne diseases. The interest in ethno-veterinary practices is growing. Ethno-veterinary offers viable alternative to conventional western-style veterinary medicine especially where the latter is unavailable, unaffordable or inappropriate. Geothermal water can be used to combat vector infestation and as a result allow herders to maintain high production levels. In its application, geothermal waters may be used in cattle dips to combat tick-borne diseases of cattle such as theileriosis, anaplasmosis, babesiosis and cowdriosis. Even though dipping of cattle in geothermal water may not control further tick attacks, continued application of this prevention measure, in Tibet (Bin 1989) and Kenya, may have overcome the challenge of tick resistance to conventional acaricides. This paper does not front ethno-veterinary alone against conventional methods but rather it draws more attention to the potential of geothermal water to unlock a vast area of useful knowledge for conditions where modern medicine is inappropriate.

2.3 Use of Geothermal Fluids for Irrigation

The semi arid areas experience short annual rainfall and thus pastoralists often face shortage of pasture for their animals and food for human consumption. Insufficient pasture and food insecurity remains a major challenge among pastoralists particularly in the present age when administrative boundaries have restricted free movement of pastoralists and their livestock. There is need for the pastoralist communities to engage in crop and fodder growing so as to become food secure. Emphasis should be laid on drought resistant crops that require less water and mature within a short period of time. Massive grazing areas should be brought under irrigation to grow either indigenous or locally developed fodder varieties. Geothermal fluids, especially condensate will be the major source of irrigation waters. Growing of pasture through irrigation will provide fodder during dry-spells and supplement wild growing animal forage. This will lead to sustained and increased animal production thus promoting value chain development in livestock industry.

Electrical Capacity (MW)	**Available water**		**Acreage Irrigated (Ha)**	**No. of Cows supported**	**Total No. of Cows if Condensate & Brine are utilized**
	Ton/Hr	**Ton/Day**			
100	8,00	19,200	6,400	51,200	102,400
1,000	8,000	192,000	64,000	512,000	1,024,000
2,000	16,000	384,000	128,000	1,024,000	2,048,000
5,000	40,000	960,000	320,000	2,560,000	5,120,000

Table 1. Amount of Acreage that can be Irrigated Using Water Acquired after Power Generation

From the table above, generation of 5,000 MW of electricity can generate 960,000 tonnes of water per day which can be tapped for irrigation purposes. Growing of fodder uses 3 tons of water per day for every hectare of pastureland. Therefore 960,000 tonnes of water will irrigate 320,000 hectares of pastureland. With each hectare capable of supporting up to 8 cows, then, there exists an opportunity of supporting a total of 2,560,000. If brine is incorporated, the total number of cows that can be supported will increase to 5,120,000.

Geothermal fluids will be the major source of irrigation waters. In order to maximize on productivity from the precious but scarce commodity, technology should be invested in heavily. A major challenge in the proposed areas may be high evaporation rates due to high temperatures and high level of salinity in its soils. To address the two setbacks, drip irrigation and development of salinity resistant crops must be employed. Approximately 234 million hectares of irrigated cropland provides about 40% of world's food supply. 20% of this area is impacted by salinity, and continued irrigation leads inexorably to increasing salinization. The ability to manage crops in saline environments and reduce reliance on fresh water is critical. According to UNESCO World Water Assessment program global demand for freshwater is forecasted to increase by 40 percent by 2025 against a corresponding 35% decrease in per capita supply by the same year.

Extensive research must be carried out in order to develop a technology that will allow a wide range of crop to produce normal yields under saline conditions. New agricultural technologies have already engineered salt tolerant rice in Africa. The technology is expected not only to increase rice productivity and profitability but to avail more fresh water for human consumption.

Below is a list of common forages, grasses, grains and field crops that may be grown using either pure geothermal waters or a mixture of geothermal and fresh water: tall wheatgrass, crested wheatgrass, wild rye, salt grass, alkali grass, sudangrass, barley, sugar beets, triticale and wheat.

Geothermal generated electricity will be used to improve lifting and distribution of underground water for irrigation, animal and domestic use. Considering the harsh environments that pastoralists inhabit, these drought resistant crops including varieties with longer shelf-life may be considered: aloe, date palms, jojoba, citrus(oranges, grapefruit, lime, lemon, tangerine); tomatoes(long-shelf life variety), cucumbers, peppers, zucchini, melons, bananas, grapes, flowers(lilies, tulips and roses); peanut, cotton, eggplant, avocado, wheat, olives, lettuce, fig and alfalfa (forage).

Growing of pasture through irrigation will provide fodder during dry-spells and supplement wild growing animal forage. Human food crops should also be grown under irrigation alongside green houses. However greenhouses should be reserved for growing food crops for human consumption. Improved production of food will guarantee the pastoral community of food security, improved health and earnings from the sale of surplus harvests.

3. RENAISSANCE OF LIVESTOCK AND DRY LAND FARMING SCIENTIFIC RESEARCH IN KENYA

From the applications mentioned above, necessity of intensive and extensive research is apparent. For a nation to attain desired achievements from geothermal energy and its related technologies, more research needs to be done particularly on crops, livestock and industrial applications. Initial benefits from pilot projects, coupled with new scientific findings and accelerated demand for more knowledge may facilitate a boom in agri-business sector and beget a decorous approach to policies that guide government operations in Kenya's ASAL areas and its engagement with the pastoralists.

CONCLUSION

Sustainable pastoralism remains a distant reverie to many pastoralists in Kenya. Sustainability in the practice of transhumance among the people of Baringo can be achieved if immediate drastic measures away from the common practices are taken. Residents should stop their reliance on rain-fed pasture alone and engage in fodder growing. This trend can be greatly supported in the near future given the proposed development of geothermal resources in North Rift. The proposed large scale production geothermal waters will help irrigate pasture reserves thus eradicating inter community wars over animal feeds. Incidences of cross-boundary movements that trigger rampant cases of insecurity would then come to an end. Besides trading in live animals, the pastoralists should engage in value addition so as to earn maximum profits. Both the county and national governments should invest heavily in research and in setting up some of the mentioned projects. Massive capital expenditure utilized properly today will save the region in question millions of shillings spent on sourcing hunger-relief food, reactive security escapades and non-sustainable short-lived projects. Emphasis should be directed towards establishing new or fostering existing sound policies that touch on pastoralism to encourage growth and self-reliance among the pastoral communities. Geothermal energy can become the turn-around factor that may provide part of the solutions to problems and uncertainty facing pastoralism today.

REFERENCE

Bee, F., M. Diyammett and E. Towo (2002) "Challenges to Traditional Livelihoods and Newly Emerging Employment Patterns of Pastoralists in Tanzania" An ILO-INDISCO Study in Collaboration with Jobs for Africa, ILO, Geneva

Bibek, R. 2001: Fundamental Food Microbiology. CRC, Press, Boca Ratin, London, New York, 2001, pp. 29-412.

Bolig, M., 2006: Coping strategies during drought. In: Disaster Risk Management in a Hazardous Environment Studies in Human Ecology and Adaptation, 2

Hall, D., S. Ehui and C. Delgado (2004) "The Livestock Revolution, Food Safety, and Small Scale Farmers: Why they matter to us all." Journal of Agricultural and Environmental Ethics 17(4-5): 425-444

Hjort, Anders. 1979. Savanna Town: Rural Ties and Urban Opportunities in Northern Kenya. Stockholm Studies in Social Anthropology, vol. 7. Stockholm: University of Stockholm.

Jahnke, H. 1982. Livestock Production Systems and Livestock Development in Tropical Africa. Kiel: Kieler Wissenschaftsverlag Vauk.

Little, P. D., K. Smith, B. Cellarius, D. L. Coppock and C. B. Barrett (2001) "Avoiding Disaster: Diversification and Risk Management among East African Herders", Development and Change 32:401-433

Little, P. 1992: The elusive granary, herders, farmers and the state in northern Kenya. Cambridge University press, The African study Centre, Cambridge

Lund, J.W. 1997: Milk pasteurization with geothermal energy. Geo-Heat Center Quarterly Bulletin, vol. 18, Klamath Falls, OR, 1997, pp. 13-15.

Lund, J.W., Freeston, D.H., and Boyd, T.L. 2005: Direct application of geothermal energy: Worldwide review. Geothermics, 34, 691-727.

Massarenti, J. 2005: Africa: New Challenges and Opportunities for Pastoralism in AFRONLINE. http://www.afronline.org/?p=22953

McCabe, J.J. (2007) Cattle Bring Us to Our Enemies: Turkana Ecology, Politics in A Disequilibrium Systems. University of Michigan Press. Michigan.

Nassef, M., S. Anderson and C. Hesse (2009) "Pastoralism and Climate Change, Enabling Adaptive Capacity", Regional Pastoral Livelihoods Advocacy Project, Nairobi and ODI, London

Ogola, F.P.A, Davidsdottir, B., and Fridleifsson I.B. 2012a: Opportunities for adaptation mitigation synergies in geothermal energy utilization- Initial conceptual frameworks. Mitigation Adaptation Strategy Global Change, (2012), 17 (5), 507-536.

Ogola, F.P.A., Davidsdottir, B., and Fridleifsson, I.B. 2012b: Potential contribution of geothermal energy in climate change adaptation. A Case Study of Arid and Semiarid Eastern Baringo Lowlands, Kenya. Renewable Sustainable Energy Rev (2012), 16, (1), 4222– 4246.

Ogola, F.P.A., Davidsdottir, B., and Fridleifsson, I.B. 2011: Lighting villages at the end of the line with geothermal energy in Eastern Baringo lowlands, Kenya - Steps towards reaching the Millennium Development Goals (MDGs). Renew Sustain Energy Rev 15 (8), 4067–4079.

Pastoralism in Sub-Saharan Africa: Know its Advantages, Understand its Challenges, Act for its Sustainability, *Inter-Reseaux*, May 2012