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Food resource availability and milk production on smallholder dairy farms in the sub-humid coastal region of Kenya

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Small-scale dairy farming provides proportionately over 0·6 of the milk produced in Kenya. Zero-grazing for smallholder dairy farms has been promoted by the Ministry of Livestock Developments' National Dairy Development Project (NDDP), but the majority of NDDP farmers are in Highland area where altitude moderates the tropical climate. Since the early 1980s, encouraged by the success of a few large and medium scale dairy farmers, attempts have been made in lowland coastal regions by NDDP to stimulate milk production from zero-grazed crossbred dairy animals on mixed crop-livestock smallholder farms.

The coastal lowland strip receives around 1200 mm rainfall annually, distributed between a reliable main rainy season (March to July), and a less reliable, short rainy season (September to December). Soils are generally sandy, well drained and subject to leaching, so that fertility is often low. Tree crops, coconut and cashew, dominate the farming system with maize the most important food crop, grown either as a sole crop or intercropped with cowpeas, beans, or cassava. In some areas land is now held under freehold tenure, but traditional tenure systems operate in other areas.

Cattle are found on 20% of farms, but only 3% of cattle in the coastal lowland zone are crossbred dairy animals. Smallholder zero-grazing dairy farms consist, on average, of a household plot of 3·0 ha, with another 2·6 ha spread across 1·5 further plots. Livestock are on the household plot which consists of 2·0 ha of natural pasture under tree crops, with 0·3 ha *Pennisetum purpureum*, 0·4 ha food crops and the remaining 0·3 ha containing houses and other buildings. The mean herd size in zero-grazing units is 2·6 animals, nearly all of which are Ayrshire, Channel Island or Friesian crossed with Sahiwal.

Farm size is decreasing as human population increases, limiting the availability of communal grazing and fallow areas. The household plot must be the source of on-farm food, because other plots are, on average, 4 km from the household plot. On the household plot, 93% of available fodder comes from natural pasture and cultivated grasses (78% and 15% respectively); crop residues make up the rest but at present are little used. Biomass production varies across years, totalling over 17 t/year with good rainfall, and perhaps half that level in poor years. Nutrient concentration varies with season from 9·0 MJ metabolizable energy (ME) per kg dry matter (DM) and 100 g/kg crude protein (CP) in the early wet season to 6·7 MJ ME per kg and 4·4 g/kg CP in the dry season when rainfall is good, and slightly lower with poor rains. Farmers do not rely only on the household plot for roughage; 76% import grass from roadsides, fallow land and uncultivated areas, and 45% use browse from fodder trees. Maize bran is the most widely used concentrate food in the coastal lowlands, and at K.Sh 1·5 per kg, is cheap when milk sells for K.Sh 8·00 per l at the farm gate. Seventy-six percent of NDDP farmers use roughage from off-farm, and 90% use some concentrate, but the frequency and quantities offered have yet to be determined. Milk production on farms linked with NDDP, is 1850 kg per cow in a 400-day lactation, with a parturition interval of 490 days.

Food requirements, which depend upon herd size, physiological state and levels of production, food availability and potential milk production are now discussed for 3-month periods, covering long rains, mid season, short rains and dry season across two complete years. The requirements are based on a herd of two cows, one calving at the beginning of the long rains (April) in the 1st year, and the second cow calving 6 months later at the start of the short rains (September). The first calf is assumed to be a heifer and is retained on the farm, the second is a bull calf and is removed from the herd. If animals consume up to the limit of their rumen capacity, as far as the biomass available from on-farm resources will allow, a cow calving at the start of the early wet season could produce 2191 kg milk in 12 months in a year with good rainfall, but only 1197 kg in a dry year.

With poor rains, the cow will have insufficient nutrients in the dry season for maintenance and production. Milk production will be reduced and conception rates will be low, lengthening the calving interval. The main constraint to milk production, particularly in the dry season, is the low level of DM intake, coupled with the low concentration of nutrients in the diet, which prevent animals consuming sufficient energy and protein for even moderate levels of milk production.

For smallholders to achieve production levels reached on commercial farms with the same crossbred animals, they would need to produce 3080 kg milk in 321 days, with a parturition interval of 403 days. Large- and medium-scale farmers rely on concentrates, often mixing ingredients on-farm. Smallholder farmers cannot reach commercial production levels without raising the nutrient concentration of the diet. Napier grass, which NDDP encourages farmers to plant, has a higher nutrient concentration than natural pasture, but the adoption rate by farmers is low, and the mean area per farm under napier decreased between 1986 and 1989. Napier has a high demand for nutrients and labour, and needs a good level of management to sustain biomass production. When poorly managed, a high proportion of napier stools die in drought years. Even if 2·3 ha napier were grown, replacing all natural pasture, smallholder farmers would be unable to reach commercial milk-production levels per cow, but would have sufficient food to increase the herd size. A cow calving at the start of the early rains could produce 2648 kg milk over 12 months in a good year, and 1754 kg in a bad year.

A high level of management skills would be needed to sustain such a large napier plot, and other on-farm sources of food may be more appropriate. Cassava, which at present is grown for human food, could also be grown as a high energy animal food. Leucaena would be a suitable protein source. Both cassava and leucaena are less susceptible to drought than napier and require less labour and nutrient inputs. Farmers are familiar with agronomic techniques for cassava production; leucaena has naturalized as a wild plant in some parts of the coast, and is already cultivated by a few farmers. If the area of natural pasture was reduced to 1·7 ha, with 0·4 ha and 0·2 ha set aside for cassava and leucaena respectively, a cow could produce 2830 kg milk in a good year and 1791 kg in a bad year. When natural pature is reduced to 1·2 ha, with 0·5 ha napier in combination with cassava (0·4 ha) and leucaena (0·2 ha), milk production could rise to 3133 kg in a good year, and 2022 kg in a bad year. Reliance on natural pasture as the major source of forage causes a high variability in milk yields between years with good and bad rainfall. When natural pasture is the main food source, milk yields are proportionately 0·46 lower when rains fail, but when napier replaces natural pasture, or when cassava (0·4 ha) and leucaena (0·2 ha) are included in the system, milk yield is only 0·35 lower.