Policy And Technology Options For Dairy Systems In East Africa: Economic And Environmental Assessment[1]

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ABSTRACT

Assessment of smallholder dairy technology was used as a case study to develop models in the SANREM decision support system. Scenarios depicting the industry before current improvements, the current situation, and forecasted improvements resulting from further adoption of technology were evaluated. GIS methods were used to establish appropriate sampling frames for field studies and analysis. Forage and livestock models supplemented reported data as input to economic and environmental models. Assessment of the impact of alternative smallholder dairy technology packages was evaluated in the Sondu river basin using watershed models driven by economic and environmental models. With demand growth from projected population increases, full adoption of the improved dairy technology package would generate total economic welfare of KS 4,206 million. Full adoption of the technology package in the Sondu river basin would increase sediment loads in the basin by 5% over a 21-year period and stream flow would increase slightly. The general models developed from initial smallholder dairy studies predict annual increases in productivity of between 0.3 and 0.5% per year would be required to sustain food prices at current levels with 2015 demand. Intensification and extensification strategies were evaluated to achieve these levels of productivity. Combinations of strategies were predicted to be the most rational in meeting future food security demands with sustainable use of natural resources.

INTRODUCTION

The importance and contribution of livestock to agricultural production is well acknowledged. Winrock International (1992) reported that livestock accounted for about 25 per cent of agricultural gross domestic product in Africa in 1988. Animals are also recognized to be an important component of the process of intensification of agriculture under sub-Saharan Africa conditions. It is apparent that as population pressure increases, farmers find they must use more intensive technologies in order to increase livestock production.

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Over the past 20 years there has been a steady infusion of dairy technologies in East Africa by National Agricultural Research systems and Ministry of Agriculture programs in conjunction with international partners. As demand for milk has increased and markets improved, there has been an evolution of dairying. Dairy breeds have been introduced and used as crossbreeds or pure breeds, and improved forage varieties have been introduced. Several management and marketing practices, including improved animal health and the use of fertilizers to enhance forage production, have been made available. National research and extension programmes have contributed to the development and adoption of improved technology. The suite of technology include:

- Improved forages with multiple fertilizer levels.

- Improved strategic application of feedstuff/minerals, primarily corn bran, and commercial concentrate feeds and mineral sources, primarily phosphorus.

- Improved animal genetics by introducing pure dairy breeds, principally Friesian and Aryshire and infusion of these breeds in the local zebu cattle, primarily East African Zebu.

- Improved animal health programs for the introduced dairy breeds to minimize the impact of external and internal parasites.

- Intensification of production system through confinement of the animals part of the time (semi-zero grazing) or complete confinement (zero-based grazing) with infusion of various stall management technologies (shedding, floor construction, bedding techniques, composting, manure/urine management).

- Retaining and rearing of male calves up to 24 months of age for sale, primarily in extensive dairying situations.

The smallholder farms outweigh the large scale commercial farms, estates and ranches in importance in terms of numbers, land use and contribution to total output. In Kenya, an estimated 3,152 million kg of milk were produced in 1996. This production involved 9.8 million animals of which 7.7% were dairy breeds (principally Friesian and Aryshire), and 10.3% zebu x dairy crosses. The remainder of the dairy population was made up of a variety of zebu breeds, such as East African zebu, sahiwal and boran. The zebu breeds produce over 57.4% of the milk produced. Four main milk production systems are described in Table 1.

Table 1. Brief description of the four major small holder dairy milk production systems in

Kenya.

Component	Zebu cattle grazing native/roadside/ plantation forage	Dairy x zebu cattle grazing native/roadside/ plantation forage	Dairy breed cattle grazing in semi-zero grazing	Dairy breed cattle with zero-grazing
Forage System	Kikuyu, stargrass, P. maximum, Themeda, other species, weeds, etc	Kikuyu, Stargrass, P. maximum, Themeda, other species, weeds, etc	Kikuyu, stargrass P.maximum, Themeda, other species, weeds, Plus Napiergrass or Rhodesgrass	Napiergrass or Rhodesgrass
Feeding system	Free or herded grazing	Free or herded grazing	Corral fed with limited tethered grazing or herding	Hand cut fodder in a corral/shed
Supplement	None	Minerals – 15 kg	Minerals – 25 kg concentrates – 450 kg	Minerals -25kg concentrates – 1000 kg
Disease control	None	Dipping	Dip and drench	Dip and Drench
Calf rearing method	3-7 month suckling	3-7 month suckling	16 wk whole milk bucket feeding	16 wk whole milk bucket feeding

The general approach of this of this study involved establishment of spatial framework, acquiring information and estimating missing data, parameterizing models, constructing sector models and testing possible scenarios. The methodology was tested in Kenya and extrapolated in Uganda and Tanzania, however this report addresses the process and outputs in Kenya.

METHODOLOGIES

Setting spatial frame

Environmental production sampling zones in Kenya were located spatially across the 6 dairy agro-ecological zones as identified by Jaetzold and Schmidt (1983). This ensured sampling of a range of environments making it possible for us to connect these traditional spatial resources to our digital spatial information system (Almanac Characterization Tool [ACT], Corbett et al. (1999)). From these zones we identified georeferenced smallholder dairy farms and we 'attached' characteristics of the environment data (edaphic and climatic variables such as annual maximum and minimum temperature, precipitation and potential evapotranspiration) contained in the foundation data in the Spatial Characterization Tool. Principle component analysis was carried out similar dairies were grouped into environmentally coherent groups (clusters). The dominant commodity-oriented dairy systems in the clusters were identified as, coastal, horticulture, coffee, tea, wheat and sheep zones. Using the spatial data in the ACT, we took these descriptions of the dairy groups and sought similar areas throughout Kenya thus converting a point description into a spatial characterization.
In order to support the agricultural sector analysis and on-farm economic analysis, representative households were defined for each of the identified commodity-oriented dairy

systems. Initial sampling frame depended on recent acquired spatial survey data. The key variables used in identification process were, farm size, land ownership, Napier grass acreage, maize acreage, number of cattle, number of dairy animals, number of indigenous cattle, predominant genotype/breeds, feeding/grazing system, distance from trading centre/market, house hold size, value of concentrate purchased, value of fodder purchased, milk production per day per cow, soil type, rainfall, altitude, mean daily temperature and household income. Principle component analysis was carried out on these variables and a multiple regression equation was established between dairy system and the other farm variables using the stepwise method (SAS, 1987). The CHART procedure (SAS, 1987) was then used on each of the principle components with uniform classes by farming system. Histograms were developed which also gave information such as frequency and percentage for each class. The midpoint (class) percentages were noted, and households with a value of the variable within the class were assigned the midpoint percentage and a sum of all the percentages of variables made. The representative farm selected (median farm) was the one with the highest total percentage score from all the variables derived from the principle components.

Once the representative farm was selected, detail location of the farm was sought and the enumerator involved in the data collection identified and contacted and the farmer interviewed. Each farm's herd structure was weighted according to the proportion of each production zone in a province to create an average herd structure by province to help serve needs in the Agricultural Sector Model.

Computing biophysical inputs for agricultural sector model

Agricultural Sector Model (ASM) is an equilibrium sectoral economics model used to conduct national and sub-national level analyses of price, production, consumption, and foreign trade responses to technology and policy by state of nature across multiple regions, farm produced commodities, and processed products. The ASM requires definition of the categories of animals within production systems, average annual yields of crops and supporting forage sources, annual nutrient requirements in terms of protein and energy, annual milk production, and annual nutrient requirement of cow units (protein, energy, intake).

Representing a composite or average view of the various production systems by administrative boundary proved challenging, given the constraints of data reporting for Kenya's livestock industry. It was decided to use seven provincial regions in Kenya for which economic and biophysical data was applied. The North Eastern province was dropped from the analysis because it represented neither an agricultural production nor a demand region (Figure 1).

To derive mean requirements and milk yield by livestock production system in each province, first a "typical herd structure" of each of the production systems in each province was determined and then the requirements of the herd per cow unit in that herd derived. The NUTBAL PRO Nutritional Balance Analyzer model (Stuth et al. 1999) was used to compute the annual requirements for crude protein, net energy of maintenance, and intake demand of the animals by breed type, class, and production system. The weighted herd structure for smallholder dairy households in each province based on the composition of the production types delineated in the study was used to define the animal classes and breed types for each province.

Once location and numbers for each of the breeds had been established, average monthly profiles were derived for each production system based on environmental conditions (derived from the ACT analysis), average nutritional values, terrain conditions, feed inputs, and potential intake restrictions. The average monthly values were run as a case for each class of animal for an entire year. The resulting monthly values were placed in an ACCESS database and assigned weighted values based on the mean herd structure for each province and production system. The weighted monthly values were then summed into annual requirements for crude protein (kg), net energy of maintenance (mcal), and intake (kg). Values for the milk cow component were on a cow unit basis. To reflect the steer fattening operations, annual requirements were derived for a 12-24 month and 24-36 month steer summed for annual production. The rangeland herd was derived based on studies of herd structure conducted by Peeler and Omore (1997).

The ASM input requires that forage resources be characterized in terms of average annual yield (kg/ha), crude protein content (%), and net energy concentration (mcal/kg) by province. Forage/ fodder resources were categorized as maize stover, Napier grass, native forage, purchased fodder, and concentrate feed for smallholder dairy. To account for beef production in the ASM system, a rangeland component was added to the matrix. Yield values were derived from area-weighted estimates based on yields of crops generated

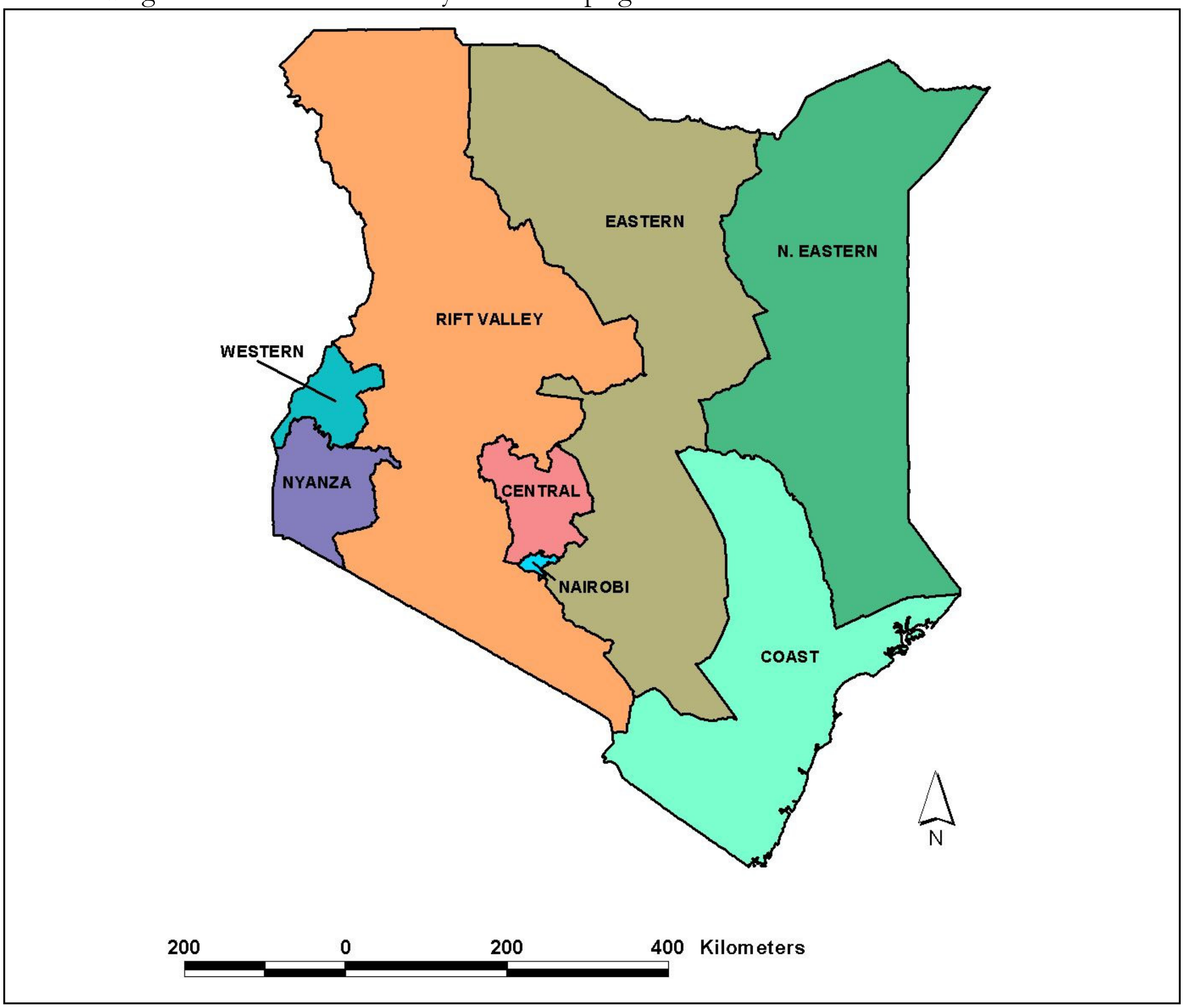

Figure 1. Provinces of Kenya

from the EPIC model and forage yields from the PHYGROW model using the household surveys of the representative farms conducted for each production zone adjusted to the provincial expected yields. Resulting yields were used to develop spatially synchronized yield probabilities needed for economic risk analysis in ASM. Forage intake by animal class and expected milk yield were generated from these diet-quality values and weather data using the NUTBAL PRO nutritional balance analyzer. A simple spreadsheet program called LAND DEMAND was created to help compute the supporting land area for the herds by provincial level identified for the agricultural sector analysis.

The Kenya Agricultural Sector Model

In Kenya ASM, the market is assumed competitive and equilibrium price and quantity are determined by the intersection of supply and demand for each commodity. Many consumers and producers are assumed to be in the competitive market. Consumers maximize their utility subject to budget constraints. Similarly, producers maximize their profit given production technology and prices; therefore, the supply function depends on prices and technology. Aggregation of each consumer demand function and each producer supply function results in market demand and supply functions. In this competitive market, social welfare is maximized when the market is in equilibrium. That is, maximum welfare will occur at the intersection of the demand and supply function. ASM includes market balance constraints and resource constraints and assumes that maximizing social welfare is the objective function. The model generates estimates of agricultural commodity prices and quantities, input use, land use and crop mixes, and consumer and producer economic surpluses.

As mentioned earlier, the Kenya ASM considered seven of the eight geographical provinces that include the Nairobi, Central, Coast, Eastern, Nyanza, Rift Valley, North Eastern, and Western regions (Figure 1). Nairobi was treated as a demand only province, and the North Eastern province is neither an agricultural production nor demand region in the Kenya ASM. The other six regions have both demand and agricultural production activities. The Kenya ASM also includes inputs on the production of 18 primary products and 9 secondary products (Table 2).

Table 2. Primary and Secondary Products in the Kenya ASM.

Primary Products		Secondary Products
Wheat	Maize	Coffee
Maize residue	Sorghum	Tea
Millet	Beans	Milk
Potatoes	Groundnuts	Pork
Raw coffee	Raw tea	Beef
Raw milk	Bull calves	Mutton/goat meat
Cull cows	Heifers	Net energy maintenance
Sheep/goats	Baconers	Crude protein
Napier grass	Native grass	Dry matter

Crop production is defined by province and agricultural zone. Livestock production activity is by province, animal type, and agricultural zone. Major crops modeled in the Kenya ASM are maize, millet, beans, wheat, sorghum, coffee, and tea. The major livestock enterprise modeled is dairy cattle; however, beef, sheep, and hogs are also modeled. Agricultural zones depict crop growth and yield potential of land and climate resources and are designated as high, middle, and low zones. Labor and land are used in the crop and livestock production activities and are limited in quantity by production region.

Commodity demand in the Kenya ASM depicts three market levels: home consumption expenditures, regional markets, and international trade. Technology improvements are evaluated by setting up different forage, animal management systems, cost of production, and associated technology adoption versions of the model to provide simulations with and without the smallholder dairy intensification technologies in Kenya agriculture. Simulation results for each technology and adoption scenario are compared to evaluate the economic impact of the technology on regional, national, and foreign consumers and producers. Current and full adoption rates for the dairy production systems are included in simulations in order to estimate past and potential economic impacts.

Current adoption rates are defined as the percentage of herds in each province using the technologies defined by the management system alternatives; the current adoption rates represent the existing mix of traditional and improved dairy production systems. Full adoption rates represent best judgments of the maximum percentages of herds using the improved dairy production systems after wide-scale introduction of the technologies. Current adoption rates for the dairy production systems were obtained from survey data from Omore et al., (1999). We consulted with experts who had experience conducting studies of adoption profiles to estimate the full adoption rates. Experts provided information on adoption profiles for the animal breed, forage and feeding, and health components of the dairy production systems.

GRAPHIC DESCRIPTION OF THE MODEL

Figure 2 shows supply and demand curves and illustrates the potential impact of technology adoption. Assume there exists aggregated demand and supply curves for a commodity in Kenya, as D Kenya and S Kenya . Also assume there is export of the commodity from Kenya to the rest of world (ROW). The excess supply curve ES Kenya is calculated from the aggregated supply curve minus the aggregated demand curve. With an improved technology that is implemented into the production system, assume the aggregated supply curve shifts from S Kenya to S' Kenya. The domestic production and export quantity increase while the domestic price decreases When the improved technology is adopted.

Consumers' surplus, producers' surplus, and foreign surplus also are changed due to adoption of the technology. Domestic consumers' surplus will increase as shown by the area of A while the change in producers' surplus will be the area of (E+D-B-A) when the improved technology is adopted. The producers' gain or loss depends on the sign of (E+D-B-A). Foreign surplus also changes as the area of (G-F). The Kenya ASM estimates these changes in consumers' surplus, producers' surplus, and foreign surplus from shifts in the milk supply resulting from the adoption of smallholder dairy technologies.

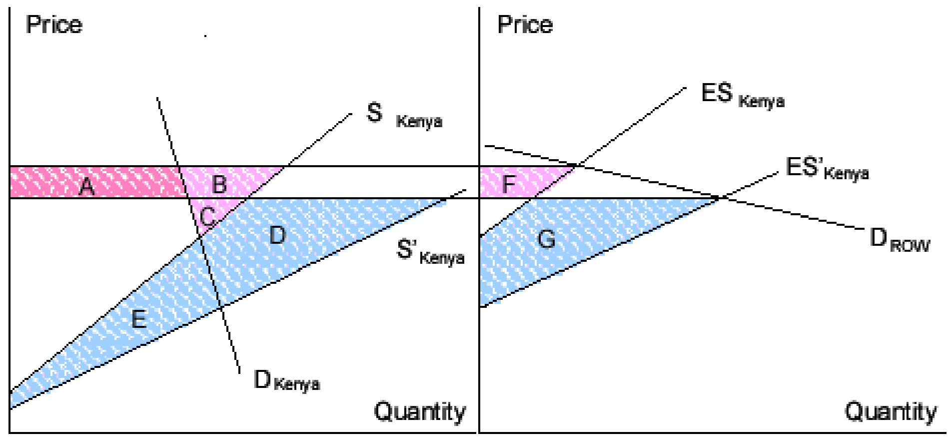

Figure 2. Welfare changes under alternative production technology in an open market.

To verify the output of the ASM, the outputs such as market prices, total production, exports, and imports for the current dairy production in Kenya were compared to observed baseline data. The base model, designated by the baseline data reflecting the current economy, was defined as improved dairy technology under current adoption rates.

ASM analysis compared results from the improved dairy technology under current adoption to the results from the traditional dairy scenarios. The improved dairy scenario allowed all the current dairy production technologies to enter the ASM solution. The current adoption rates for systems 2, 3 and 4 as shown in Table 3 limit the mix of these technologies in the simulation. The traditional dairy scenario allows only the zebu cattle dairy production technology to be used to meet current demand. The results of this comparison showed the past impact of technology adoption.

Improved dairy technology under current adoption was compared to the improved dairy technology under full adoption rates. Price, production, input use, and welfare components were compared in the following economic impact assessments. This comparison showed the potential impact of expanded technology adoption. Estimates of current and future adoption rates were made using a panel of national research and extension experts.

RESULTS OF THE ASM: PRICE AND PRODUCTION

Results of the ASM showed that improved dairy technology has had a positive effect on the Kenyan economy and social welfare. Further positive impacts are possible under a full adoption scenario, although the bulk of the benefits has already been achieved given current demand. As population increases, demand will be created. Future improvement in dairy production is most likely to meet the growing demand.

If current demands had to be met with traditional dairy technology rather than improved dairy technology under current adoption rates, the raw milk price would be 16.31Ksh/kg, which is 6.1% higher, as shown in Table 4. The quantity of raw milk produced would be down by 48.5%. Regional demand for milk in the urban areas of Kenya would drop by some 58 thousand tons and the deficit supply for milk would have to be met with increased imports, totaling some 1.58 million tons with an import price of 18 Ksh/kg (Tables 4 and 5). The burden of the price increase for raw milk would fall primarily on home consumption by farmers and their families. Price, production, and regional demand for other commodities would not be significantly affected. The major change in commodity production and price would be a 7.9% decrease in wheat production with a corresponding 2.17% price increase.

Regional milk production would decrease if the Traditional Dairy technology was currently in use to produce all milk and provincial shifts in wheat, maize, millet, and bean production also would be expected. The Rift Valley and Nyanza provinces would experience increases in maize and bean production while the Western province would have decreases in production of these two crops. Thus, one result of the development and adoption of the improved dairy technologies has been to foster these changes in land use and crop production.

Table 3. The definition of dairy cattle technology and adoption rates for the animal breed/feed/management system alternatives.

Scenarios	Allowed dairy production technology	Allowed sources for feed
Improved dairy current adoption	Zebu-cattle, (1) Cross breed cattle, (2) Dairy breed cattle with semi zero-grazing, (3) Dairy breed cattle with zero-grazing. (4)	Napier grass maize residue native grass
Traditional dairy	Zebu-cattle (1)	Maize residue native grass
Improved dairy full adoption	Zebu-cattle, (1) Cross breed cattle, (2) Dairy breed cattle with semi zero-grazing, (3) Dairy breed cattle with zero-grazing. (4)	Napier grass maize residue native grass

Cattle Breed/ Feeding * Province	Current adoption (%) **				Full adoption (%) **			
	1	2	3	4	1	2	3	4
Central	5	5	20	70	0	0	20	80
Coast	75	10	10	5	60	15	15	10
Eastern	50	10	20	20	30	15	25	30
Nyanza	75	10	10	5	40	15	20	25
Rift Valley	50	5	15	30	30	10	25	35
Western	80	10	5	5	40	25	10	25

* The proportion of dairy breed/feeding system (1) representing the traditional zebu breed of cattle with grazing of native grass and feeding of maize residues is allowed to enter the ASM algorithm at 100% with the numbers for the dairy technology systems 2, 3, and 4 constrained to zero percentages for each region under the traditional dairy scenario.

** Defined as the percent of total animals in dairy herds using the technologies defined by the animal breed/feed/management system alternatives. Full adoption represents the maximum percentage of total animals in dairy herds that would use animal breed/feed/management systems 2, 3 and 4.

Table 4. Milk price, production, import and export under 18 Ksh import milk price in the Kenya ASM.

Unit: Ksh/kg, ton, million Ksh

Scenario	Price	Production	Import	Export	Welfare
With 18 Ksh/kg import price					
Improved dairy current adoption	15.37	3729172	36365	36365	201967
Traditional dairy	16.31	1918101	1616774	36365	199083
Improved dairy full adoption	15.05	3742136	36365	36365	202672

The improved dairy current adoption scenario resulted in an estimated 285 thousand fewer number of cows required to produce the raw milk to satisfy total demand compared to the traditional dairy scenario. Dairy cows numbers in the Central and Rift Valley provinces were 408,323 and 1,124,878 head, respectively, under the improved dairy current adoption scenario. Under the traditional dairy scenario, the Central province would have been required to increase cows by 67% to produce sufficient milk to meet current demand. The Rift Valley province would have 1,072,526 dairy cows, a 4% decrease in cow numbers. The Eastern and Western provinces would experience increases in cow numbers by 95.2% and 30.0%, respectively, while the Coast and Nyanza provinces would reduce cow numbers by 31.5% and 88.2%, respectively.

If full adoption conditions existed, given the current 1995 demands for the commodities, raw milk production would be increased an additional 12.9 thousand tons and the price of raw milk would be reduced 2.0%. Wheat production would be decreased by 5.4 thousand tons with a corresponding increase in price of 0.34 Ksh/kg. Provincial consumers in the urban areas would increase their consumption of the additional amounts of milk. Under the improved dairy full adoption scenario, total cow numbers would be expected to decrease in the Central (24.4%), Eastern (17.3%), Rift Valley (41%), and Western (37.8%) provinces, while increasing substantially in the Coast (243.2%) and Nyanza (25.3%) provinces.

CHANGES IN LABOR AND CROP LAND INPUTS

Labor and crop land usage (Table 5) shows that the changes in labor and crop land use varies among regions and between the dairy technology scenarios. Both labor and crop land use would be lower under the traditional dairy scenario as compared with the improved dairy current adoption scenario. Full adoption conditions for the improved dairy technologies would reduce both labor and crop land usage from the current adoption scenario.

WELFARE EFFECTS

Producers' surplus would be 0.5 billion Ksh, or 7.4%, less annually if Kenya were dependent on the traditional dairy technologies (Table 5). The increase in price for the commodities would not offset the reduction in quantities produced, resulting in a slight decrease in total returns to farmer and family labor and land. Producers in most regions would experience a decrease in returns to these resources; however, producers in the Eastern province would have 15 million Ksh more income annually. Home consumption expenditures would be higher in each region under the traditional dairy technologies. For Kenya as a whole, these expenditures would be an additional 2.24 billion Ksh or 4.1%, annually. When the change in producer surplus and home consumption expenditures are combined, a measure of the net economic benefits to farmers and their families from the improved dairy technology is obtained. The improved dairy technologies under current adoption conditions resulted in 2.74 billion Ksh annual net gain to producers and their families.). If Kenya relied solely on traditional dairy technologies to meet current demands, total social welfare in Kenya would be decreased 2.883 billion Ksh, or 1.43%, annually (Table 6). Most of the reduction in social welfare would result from substantially increased imports of milk.

Table 5. Regional land and labor usage, producers and consumer's surplus, and home consumption expenditure in the Kenya ASM.

Item by Province	Improved dairy current adoption	Traditional dairy		Improved dairy full adoption	
		Change	Percentage	Change	Percentage
	(Value)	(Value)	(%)	(Value)	(%)
Labor (1000 man days)					
Central	82775	3991	4.82	-5734	-6.93
Coast	15155	-4106	-27.09	25138	165.87
Eastern	71000	930	1.31	0	0
Nyanza	132770	-11775	-8.87	5462	4.11
Rift Valley	200718	-17753	-8.84	-27417	-13.66
Western	67062	-1538	-2.29	1570	2.34
Crop land (1000 ha)					
Central	746.49	-17.35	-2.32	-14.53	-1.95
Coast	796.00	0	0	132.71	16.67
Eastern	3769.87	-573.59	-15.22	169.67	4.50
Nyanza	1252.01	0	0	0	0
Rift Valley	2527.33	-465.27	-18.41	-539.40	-21.34
Western	3354.81	31.67	0.94	-39.47	-1.18
Producers' surplus (million Ksh)					
Central	602	-21	-3.44	-115	-19.07
Coast	14	-17	-117.53	127	900.00
Eastern	112	15	13.02	4	3.97
Nyanza	4068	-25	-0.62	1	0.02

Rift Valley	1664	-420	-25.22	-524	-31.50
Western	301	-32	-10.64	0	0
Home-consumption expenditure (million Ksh)					
Central	-10907	-700	6.42	-12	0.11
Coast	-2012	-93	4.64	25	-1.24
Eastern	-6362	-300	4.72	4	-0.06
Nyanza	-4597	-208	4.52	82	-1.79
Rift Valley	-28029	-866	3.09	535	-1.91
Western	-2561	-77	3.00	9	-0.34
Consumers' surplus (million Ksh)					
Nairobi	45239	-231	-0.51	-44	-0.10
Central	18778	-194	-1.03	6	0.03
Coast	6995	-23	-0.33	28	0.40
Eastern	19380	37	0.19	32	0.16
Nyanza	14252	39	0.28	104	0.73
Rift Valley	47965	-132	-0.23	37	0.08
Western	7807	47	0.60	16	0.21

Full adoption of the improved dairy technologies would result in a net economic gain to producers and their families in Kenya. Producers' surplus would decrease 506 million Ksh annually but home consumption expenditures would decrease 642 million Ksh annually, or 1.18% annually, resulting in a net annual economic gain of 136 million Ksh (Table 6). With the adoption of the improved dairy technologies, total social welfare increased an additional 2884 million Ksh annually. These results indicate that the improved dairy technologies have substantially benefited producers and their families through expanded supplies and lower prices for milk and other commodities and through reduced milk imports. The results also indicate that when the improved dairy technologies are fully adopted, consumers' and national economic welfare would be further increased, but farmers and their families would realize only modest gains in their economic benefits. Reductions in the returns to land and labor resources would be nearly equal additional savings in home consumption expenditures for rural people.

Table 6. Welfare comparison under alternative scenarios with 18 Ksh/kg milk import price.

Unit: Million Ksh, %

Welfare measure	Improved dairy current adoption	Traditional dairy	Improved dairy full adoption
Consumers' surplus	160416	159959 (-0.29)	160596 (0.11)
Foreign surplus	89260	89578 (0.36)	89651 (0.44)
Producers' surplus	6761	6262 (-7.39)	6255 (-7.49)
Home consumption expenditure	-54471	-56716 (4.12)	-53829 (-1.18)
Total social welfare	201967	199083 (-1.43)	202672 (0.35)

ECONOMIC IMPACTS OF ALTERNATIVE DAIRY PRODUCTION SYSTEMS

UNDER FUTURE DEMAND GROWTH CONDITIONS (2015)

The improved dairy current adoption base model solution were compared with the simulation reflecting full adoption of existing dairy production technologies under projected 2015 demand conditions. Population projections to year 2015 in urban and rural areas within each province of Kenya were used to project food demands by commodity. Projected food demands for farmer and family home-consumption and domestic regional consumers in towns and cities by province were based on current per capita consumption rates for each commodity by province and place of residence, i.e. rural or urban.

PRICE AND PRODUCTION

Wheat and millet prices increase 17.6% and 19.0%, respectively. All other commodity prices are within 1.0% to 6.0% of base 1995 price levels. Raw milk price decreases 0.9 Ksh/kg, or 5.86%. Corresponding increases in production quantities of 438.7 and 40.5 thousand tons, or about 695.0% for wheat and 74.0% for millet, respectively, would be required to meet projected demand levels. Milk production would increase 1.41 million tons, or some 117.0% to meet future demands by regional consumers in towns and cities and home-consumption by farmers and their families.

Home consumption for cereal grains, potatoes, and groundnuts would near double. Milk consumption by farmers and their families would increase 113.0%. Domestic regional consumption would more than double for wheat, maize, potatoes and groundnuts, and increase 68.0% and 85.0%, respectively, for sorghum and millet. Quantity of milk consumed by regional domestic consumers would increase 117.0%. Yield increases to meet projected 2015 demands at near 1995 price levels would need to average about 0.3% to 0.5% per year for maize, potatoes, sorghum and raw milk. Yields for beans and raw coffee would need to increase about 0.9% annually, while beef and millet yields would need to grow at a 2.5% annual rate. Groundnut yields would need to increase near 4.5% per year, while wheat yield would require an annual growth rate of 6.25% to meet 2015 projected demands at near 1995 price levels.

WELFARE EFFECTS

When the dairy technology improvements are fully adopted under demand growth rates associated only with rising population for the next 15 years, as contrasted to current adoption rates and demand levels, both consumers and producers are beneficiaries. Regional consumers in towns and cities nationally gain 181.54 billion Ksh (113.2%) annually, while home consumption expenditure by farmers and their families is increased 58.3 billion Ksh (107.0%) annually. Producers return to land and labor are increased 11.8 billion Ksh each year. The increase in home consumption expenditure for food substantially outweighs the increase in producers return to land and labor. Foreign surplus increases only slightly, up 274 million Ksh annually, or about 0.3%. Total social welfare in Kenya is increased 135.31 billion Ksh (67.0%) annually under the demand growth scenario. Increased production and consumption of milk accounts for near one-third of the increase in welfare of regional consumers in towns and cities, and about 72.0% of the increase in home consumption expenditures of farmers and their families. These results indicate that even under demand growth conditions, domestic consumers in towns and cities are likely to be the major beneficiaries of the smallholder dairy research and technology transfer relative to rural producers and their families that adopt the new technologies and increase the available domestic supply of milk.

CONCLUSIONS

Improved dairy technology had a positive effect on the Kenyan economy and social welfare by substantially benefiting producers and their families through expanded supplies and lower prices for milk and other commodities and through reduced milk imports. The results also indicate that when the improved dairy technologies are fully adopted, consumers and national economic welfare would be increased, but farmers and their families would realize only modest gains in their economic benefits. Reductions in the returns to land and labor resources would be nearly equal additional savings in home consumption expenditures for rural people.

When the dairy technology improvements are fully adopted under demand growth rates associated only with rising population for the next 15 years, as contrasted to current adoption rates and demand levels, both consumers and producers benefit. The increase in home consumption expenditure for food substantially outweighs the increase in producer's return to land and labor. Increased production and consumption of milk accounts for near one-third of the increase in welfare of regional consumers in towns and cities, and about 72% of the increase in home consumption

expenditures of farmers and their families. These results indicate that even under demand growth conditions, domestic consumers in towns and cities are likely to be the major beneficiaries of the smallholder dairy research and technology transfer relative to rural producers and their families that adopt the new technologies and increase the available domestic supply of milk.

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