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Fertilizer retailing in the Kenyan Highlands

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Abstract

Local retailers of agricultural supplies in developing countries occupy an important link in the dissemination of agricultural technologies but little is documented on their business activities in the Highlands of Kenya. Kenya's fertilizer markets were liberalized in 1990 and since then a steady increase in the proportion of fertilizers imported through commercial channels has occurred. A short, formal survey was conducted among 139 retailers in 74 market centres located in six Provinces of Kenya. Business operators were asked about the formulations and prices of fertilizers sold, product repackaging, sources and dissemination of product information, sales trends and the availability and extension of credit. Retailers were found to market a total of 17 different fertilizers, with each retailer marketing an average of 4.5 types. Retailers provided specific recommendations concerning their products to farmers with 81% considering this an important part of their business activities. Many retailers' recommendations are based upon written information and testing on family farms but others were unable to justify the basis of their recommendations. More than twice as many retailers extended credit to customers (31%) than was extended to them by their suppliers (14%). Two important national indicators of fertilizer marketing, total supply and consumption, do not significantly differ when the seven years before and after onset of market reforms started in 1990 are compared but other, more subtle national indicators suggest that successful fertilizer marketing reforms are in progress. There is a significant decrease in the proportion of annual 'carry-over' of fertilizer stocks ($p = 0.04$) resulting from a shift from distribution by parastatal to privatized operations and a significant positive trend in commercial fertilizer imports over time since the implementation of market reforms ($r = 0.97$).

Introduction

Per capita food production continues to decline in sub-Saharan Africa (FAO, 1995), much to the concern of national planners and international agencies active within the subregion. Much food insecurity is rooted in the failure of the 'green revolution' to impact on the smallhold farming sector (Okigbo, 1990), unlike elsewhere in the tropics (Harwood, 1990). The basic production strategy of increasing crop yields through the use of external inputs applied to improved germplasm remains operational, but in practice it has been greatly restricted by the inability of farmers to invest in farm improvements. At the same time, increased population pressure and the accompanying reduction in size of land holdings have resulted in nutrient-depleted continuous cropping systems (Sanchez et al., 1997) whereby a greater portion of the harvest must be retained to feed the household (Woomer and Muchena, 1996).

The marketing of fertilizers in Kenya has recently undergone rapid transition as a result of market liberalization within Structural Adjustment Programmes (Kimuyu, 1994). At the beginning of the 1980s, the Government of Kenya was closely involved in the marketing of fertilizers through price controls and importation quotas. Fertilizers were channelled through parastatal farmers' organizations and donor contributions were often sold at prices well below market value. These policies resulted in a defacto state monopoly in fertilizers as they discouraged private commercial activities. In 1990, fertilizer prices were

decontrolled and import quotas abolished. In 1993, licensing systems were relaxed and the currency market decontrolled, resulting in open, competitive markets (P.M. Amukoa, pers. comm.).

Due to the absence of economically-viable indigenous agromineral deposits, Kenya relies on imports to meet its fertilizer needs. In 1996, imports were approximately 226 000 MT with smallhold farmers accounting for 35–40% of the market (Allgood and Kilungo, 1996). Smallhold farmer access to fertilizers has greatly improved through the market liberalization process with over 5000 private sector retailers reported by Allgood and Kilungo (1996). The World Bank (1995) estimates potential consumption of fertilizers in Kenya to be about 1 041 000 MT assuming that commercial crops (wheat, sugarcane, coffee and tea) are fertilized at 100% and smallholder crops (maize, sorghum, beans and potatoes) are fertilized at 50% of their recommended doses, respectively.

One of the objectives of structural reforms in Africa is to remove bottlenecks in the allocation of agricultural inputs through medium-term, supply-side policies (Alexandratos, 1997). Assuming that sufficient time has elapsed since the liberalization of fertilizer markets, we have attempted to determine its early success through compiling and analyzing reports of fertilizer importation and consumption in Kenya over the past 14 years (i.e. seven years before and after the onset of market reforms). One area of support for improvement in fertilizer use by smallhold farmers remains difficult to access, namely the strategies practised by retailers of agricultural supplies. These entrepreneurs are, in effect, determining the local availability and prices of fertilizers in remote rural settings. The objective of this study is to better understand the role of local retailers in fertilizer supply, information exchange and credit extension. To accomplish these objectives, a survey was conducted among retailers serving smallholder communities in the Kenyan Highlands and their business practices were related to changes in fertilizer indicators at the national level.

Materials and methods

Kenyan national fertilizer statistics

Basic data were collected on fertilizer imports, donor contributions, consumption and annual carry-over between 1983 and 1995 from published (Allgood and Kilungo, 1996; Kimuyu, 1994) and unpublished sources for 1996 (P.M. Amukoa, pers. comm.). The data were obtained for fiscal years but presented by report year, hence fertilizer statistics for July 1982 through June 1983 were entered as data for 1983. Carry-over stocks are not the simple difference between supply and consumption within report years, but rather account for fertilizer exports from surpluses during the following year (Allgood and Kilungo, 1996; Kimuyu, 1994). These data were compiled by computer and secondary statistics were calculated (% donor provided fertilizers and% carry-over fertilizers). Case years were assigned categories of either prior to (1983–1989 inclusive) or after (1990–1996 inclusive) liberalization of fertilizer markets. The computer spreadsheet was checked for errors and imported into a computer statistics program (Wilkenson, 1990). Data were sorted by categories as defined above, means calculated and differences tested with Tukey *t*-Test. Overall and categorized data were correlated with report years by Pearson Pairwise analysis. Linear regression was performed with the percentage of fertilizers marketed through the commercial sector [= (100 – % donor imports)/total imports] with time and the *y*-intercept, from which slope and regression coefficient (*r*) were calculated. When conducting the linear regressions, 1983 and 1990 were arbitrarily assigned year values of 0 with annual incremental increases up to 6 in order to account for the effects of time seven years before and after the implementation of structural reforms, respectively.

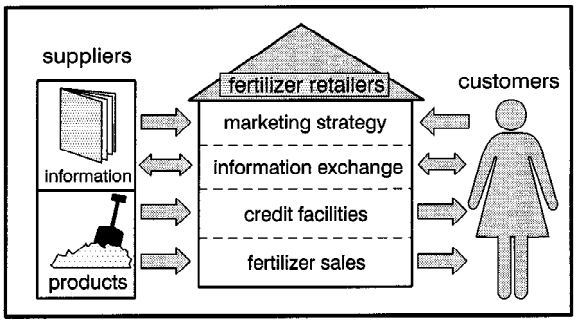

Figure 1. A simple conceptual model of agricultural retail operations.

Survey of fertilizer stockist activities

The business strategies of 139 retailers of agricultural supplies were assessed through a 23-question, formal survey conducted in six Provinces and 17 Districts in the Kenyan Highlands between June 1996

Table 1. Provinces and number of Districts surveyed in the Kenyan Highlands and the number of interviews conducted

Province	Districts	Interviews	Comments
Central	6 of 6	64	Sub-humid with bimodal rainfall, dominated by small-scale market agriculture, close proximity to Nairobi markets
Eastern	5 of 10	17	Semiarid climate, only Districts adjacent to Central Province were sampled
Nairobi	1 of 1	3	Garden/farm suppliers in peri-urban areas adjacent to Central Province
Nyanza	2 of 7	20	In the Lake Victoria Basin, dominated by subsistence agriculture, only Districts adjacent to Western Province were sampled
Rift Valley	1 of 17	14	Only Laikipia District, adjacent to Central Province was sampled, dominated by small-scale mixed farming
Western	2 of 5	21	Mainly highly weathered, infertile soils, dominated by subsistence agriculture

and February 1997 (Table 1). The areas surveyed contained densely populated, smallholder landscapes. A conceptual model of retail operations was developed which describes retailers as following various business strategies, marketing fertilizers, exchanging information and receiving and extending credit (Figure 1). The first draft of the survey was informally field tested among six retailers along the outskirts of Nairobi. As a result of this practice, the phrasing and order of some queries were revised. A single enumerator visited 74 business centres of larger villages and towns using public transport and asked for directions to local retailers of agricultural supplies. Between one and six retailers were surveyed at each business centre. A short letter was given to the operator of the shops explaining the purpose of the survey and requesting their cooperation. Retailers were assured that their individual answers would not be cited. Each survey required about 20 min to complete with the enumerator asking questions and entering information into previously prepared forms.

Shop operators were queried concerning the number of years in business, types and prices of fertilizers marketed, whether or not they repackaged fertilizers, the number, size and types of fertilizers repackaged, the relative importance of pesticide, seed, livestock supplies and fertilizers, sources of new products, knowledge of local agricultural extension agents, availability and distribution of written information, availability and extension of credit and their 'open ended' opinions on prevailing business conditions. During the interview, the enumerator estimated the size of display areas and the proportion displaying fertilizers. Following the interview, the enumerator ranked retailers as being interested and cooperative, moderately cooperative, or reluctant and suspicious.

Survey results were compiled into a computer spreadsheet with cases (interviews) entered as rows and responses as columns. Replies to open-ended questions were grouped into categories and entered as codes. The spreadsheet was inspected for accuracy and then imported into a computer statistics programme for sorting and calculation of summary statistics (Wilkenson, 1990). The importance of various retail products, fertilizers, pesticides, seeds and plants and livestock supplies, was calculated by summation and averaging of ranks 1 through 4, with the lowest rank indicating that the product is least important among the four categories.

Results

Kenyan national fertilizer trends and market reform

Total fertilizer supplies comprising commercial im-

Table 2. Fertilizer supply and consumption seven years before and after implementation of Structural Adjustment Programmes (SAPs) and liberalization of fertilizer marketing in Kenya

Marketing indicator	Before SAPs (1983–1989)[2]	After SAPs[1] (1990–1996)	*t*-Test *P*
Commercial imports ($\times 10^3$ t yr^{-1})	151	173	0.50
Donor shipments ($\times 10^3$ t yr^{-1})	106	78	0.35
Total supply ($\times 10^3$ t yr^{-1})	256	251	0.88
Total consumption ($\times 10^3$ t yr^{-1})	204	246	0.08
Annual carry-over[3] ($\times 10^3$ t yr^{-1})	45	9.4	0.07
Donor provided/total (%)	39	34	0.55
Carry-over/total (%)	18	2.6	0.04

[1] Marketing liberalization was initiated in 1990 and completed in 1993.
[2] Reporting years, data covers July of previous year through June of reporting year, some errors occur due to rounding.
[3] Carry-over stocks account for fertilizer exports during following year.

Table 3. Correlation matrix of fertilizers marketing indicators with time between 1983 and 1996 in Kenya, a period seven years before and after implementation of Structural Adjustment Programmes (SAPs) which included liberalization of fertilizer markets

Indicator correlated with time	Overall (*r*)	before SAPs (*r*)	After SAPs (*r*)
Commercial imports ($\times 10^3$ t yr^{-1})	0.41	–0.41	0.97***
Donor shipments ($\times 10^3$ t yr^{-1})	–0.09	0.85*	–0.73
Total supply ($\times 10^3$ t yr^{-1})	0.15	0.60	0.92**
Total consumption ($\times 10^3$ t yr^{-1})	0.77*[a]	0.95**	0.71
Annual carry over ($\times 10^3$ t yr^{-1})	–0.59*	–0.48	0.72
Donor provided/total (%)	0.20	0.86*	–0.90**
Carry over/total (%)	–0.66*	–0.74[b]	0.71

[a] * $p \leq 0.05$, ** $p \leq 0.01$, all others are not significant.
[b] $p = 0.06$.

ports and donor shipments were not significantly different in the seven years before and after the onset of marketing reforms in 1990 (Table 2). Strong trends were noted in increased consumption following reforms ($p = 0.08$) and reduced carry-over of stocks between years ($p = 0.07$). The matrix correlating fertilizer marketing categories with time (Table 3) indicates an increase in commercial imports since 1990 ($r = 0.97$) and a decline in fertilizer contributions by donors ($r = –0.90$). No significant trends in overall fertilizer supplies were noted over the past 14 years, either before or after the onset of structural reform of fertilizer marketing, on the one hand because a decrease in donor contributions was compensated by an increase in commercial imports and on the other hand because of large year-to-year variations within each category (data not presented).

Agricultural supply retail operations and fertilizer marketing

A total of 139 retail operations in 74 market centres were surveyed in six Provinces. Of the retailers interviewed, 30% were ranked as being very cooperative and interested in the study and 22% were either suspicious or reluctant to answer some questions. Five retailers refused to be interviewed. The average retail location had 61 m^2 of display area, 10 m^2 of which was devoted to fertilizers (Figure 2). The average business had been in existence for 7.6 years. Overall, 53% of the retailers reported a slight decline in fertilizer sales as compared to five years ago. The retailers tended to practice balanced marketing strategies between fertilizer sales (29%), pesticides (26%), livestock supplies (24%) and seeds and plants (21%). Business

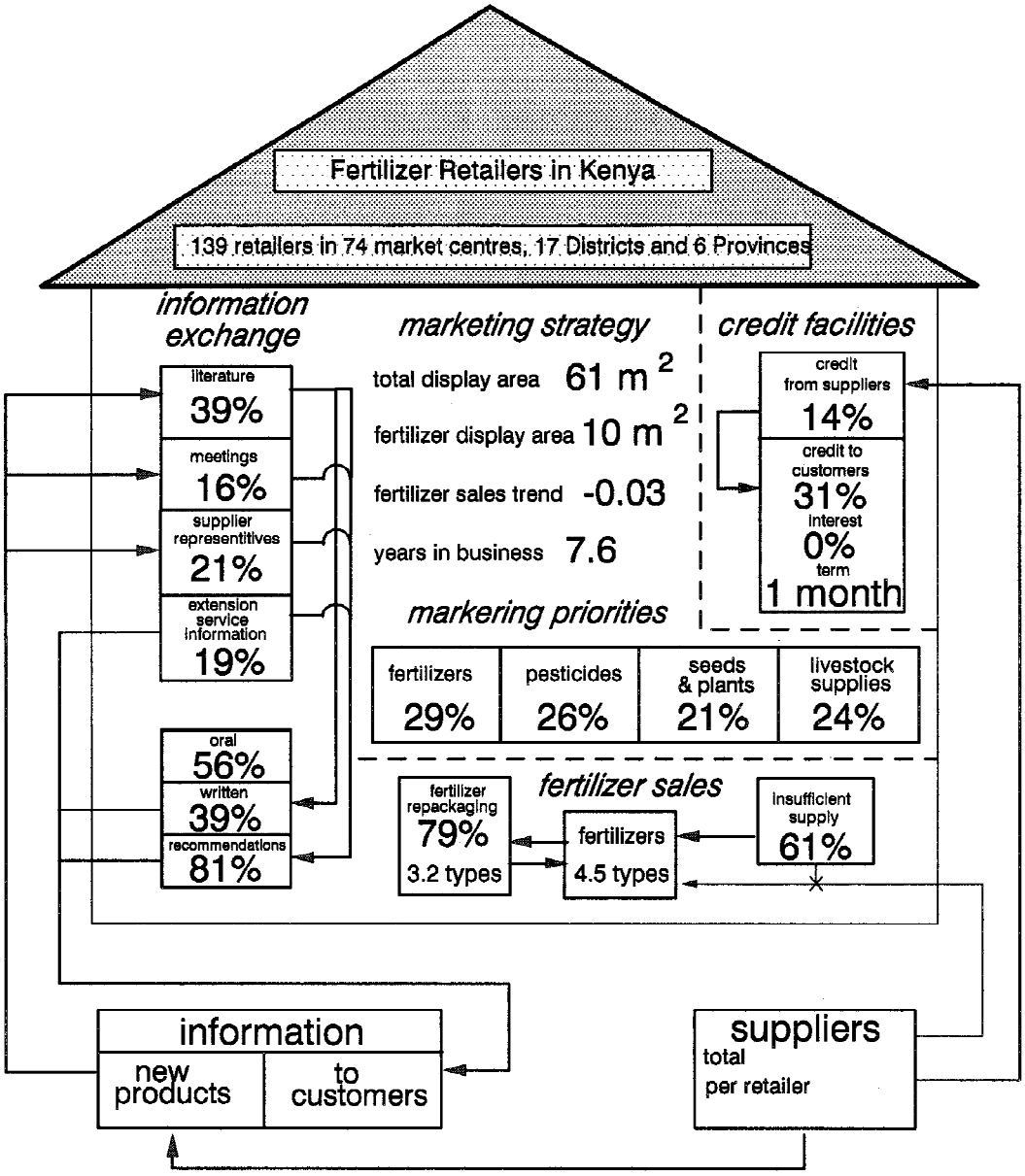

Figure 2. Marketing strategy, fertilizer sales, information exchange and credit extension of agricultural suppliers in the Kenyan Highlands.

activities that are not necessarily related to agriculture, such as sales of hardware and construction materials, were not considered in the survey.

Retailers reported the marketing of a total of 17 different fertilizers, with each retailer handling an average of 4.5 types. Significant differences were observed in the number of fertilizers marketed in Central Province as compared to Nyanza and Western Provinces (Table 4). The most commonly available fertilizers were Diammonium Phosphate (94%), Calcium Ammonium Nitrate (81%), Urea (43%) and Triple 17 (29%) (Table 5). Relatively few retailers marketed superphosphates (13%), potassium-bearing fertilizers (4%), agricultural lime (6%) or rock phosphates (1%). Many shops provided foliar fertilizers in small quantities (70%) while few sold organic materials such as compost, manure or bone meal (2%). Repackaging of fertilizers into smaller quantities was reported by 79% of retailers. On average, 3.2 types of fertilizer were repackaged (Figure 2), most often into

Table 4. Years of operation, number of fertilizers sold and repackaged and the frequencies of product recommendations, awareness of local extension agents and periodic disruption in fertilizer supply reported by Province[1]

Province	Years of operation (yr)	N of fertilizers Sold	Repackaged	Recommend products (%)	Identified agent (%)	Report shortages (%)
Central	7.7 ns[2]	5.5 a[3]	3.9 a	84	13	71
Eastern	7.7	3.8 ab	2.0 b	100	12	76
Rift Valley	5.9	4.8 ab	3.2 ab	78	28	50
Nyanza	6.9	3.1 b	2.3 b	76	26	55
Western	9.6	2.8 b	2.5 ab	60	30	60

[1] Nairobi Province excluded from analysis.
[2] ns = differences within column are not significant.
[3] Treatments with the same letter are not significantly different within column by pairwise Tukey *t*-test ($p = 0.05$).

Table 5. Types, forms, frequency, Kenya Shillings per 50 kg bag, nutrient contents and unit costs per nutrients of fertilizers marketed by local agricultural supply retailers in the Kenyan Highlands

Type Form	Frequency[1] (%)	Price (KSh 50 kg^{-1})	Nutrients (NPK 50 kg^{-1})	Unit cost[2] (KSh kg^{-1})
Nitrogen-bearing				
Calcium Ammonium Nitrate	81	1170	13 kg N	90
Urea	43	1335	23 kg N	58
Ammonium Sulfate Nitrate	11	1176	13.5 kg N	87
Ammonium Sulfate	3	1000	10.5 kg N	95
Phosphorus-bearing				
Triple Super Phosphate	11	1294	10 kg P	129
Single Super Phosphate	2	1085	6.3 kg P	172
Minjingu Rock Phosphate	1	950	6.5 kg P	146
Potassium-bearing				
Murate of Potash (60% KCl)	4	965	16 kg K	60
Nitrogen & Phosphorus-bearing				
Diammonium Phosphate	94	1555	9 kg N, 10 kg P	81
'Double 20' (20-20-0)	34	1320	10 kg N, 4.5 kg P	91
Monoammonium Phosphate	23	1279	5.5 kg N, 11 kg P	78
'Double 23' (23-23-0)	20	1285	11.5 kg N, 5 kg P	78
Compound (N-P-K-bearing)[3]				
'Triple 17' (17-17-17)	28	1225	8.5 kg N, 3.7 kg P,7 kg K	64
20-10-10	6	1250	10 kg N, 2.4 kg P, 4.1 kg K	76
25-5-5 (+5% Sulphur)	4	1085	12.5 kg N, 1.2 kg P, 2.1 kg K	69

[1] Frequency (%) of sales by 139 local retailers.
[2] Considers nitrogen, phosphorus and potassium to have equal values in fertilizers bearing multiple nutrients, does not consider calcium or sulphate, study conducted when the exchange rate was approximately KSh/52 = US $1.00.
[3] Table omits the compound fertilizer 18-4-12 occasionally applied to coffee and agricultural lime.

Table 6. Fertilizer prices (Ksh per 50 kg bag) in three areas of the Kenyan Highlands

Survey areas	DAP[1]	CAN[2]	Urea
Central Province	1461 a[5]	997 a	1290 a
Outlying Provinces[3]	1487 a	1165 b	1250 a
Western Kenya[4]	1737 b	1368 c	1452 b
Probability[6]	<0.001	<0.001	0.001

[1] Diammonium Phosphate.
[2] Calcium Ammonium Nitrate.
[3] Districts of East and Rift Valley Provinces adjacent to Central Province.
[4] Combines Nyanza and Western Provinces.
[5] Letters within columns (a, b, c) denote significant differences ($p = <0.03$) by pairwise Tukey *t*-tests.
[6] Overall probability of Tukey *t*-test.

quantities of 1 and 2 kg but occasionally into packages as small as 100 g and as large as 5 kg (data not presented). The most frequently repackaged fertilizers were Diammonium Phosphate (76% of retailers), Calcium Ammonium Nitrate (61%) and various compound formulations (37%). In Central Province, significantly more fertilizers were repackaged than in the Eastern and Nyanza Provinces (Table 4). A strong correlation was observed between the number of fertilizers sold by a shop and the number repackaged by the retailer ($r = 0.65$, $p < 0.001$). Periodic shortages of fertilizer occurred at 61% of the retail outlets, with shortages being most pronounced in provinces furthest from Nairobi (Tables 1 and 4).

Retailers provided specific recommendations concerning their products to farmers. Of the retailers questioned, 81% considered providing recommendations an important part of their business activities. Only 19% of the retailers could identify the local agricultural extension agent (Figure 2) and differences in extension awareness exist between Provinces (Table 4). Our survey indicated that product literature provided by the retailer's suppliers were an important source of information. Literature was given by suppliers to 39% of the retailers and 19% had attended meetings organized by them. Retailers were better able to identify the local distribution agents of their wholesale contacts rather than local extension agents. While it is comforting to know that suppliers receive and disseminate information about their products, it is important to note that those who provide technical messages also enjoy an immediate benefit from the sale of these products sold. In Nyanza and Western Provinces, 81% of the retailers reported that their recommendations were in part based upon experiences from family farms. More than twice as many retailers extended credit to customers (31%) than was extended to them by their suppliers (14%). Retail credits were generally short-term (1 month to 1 season) and interest-free.

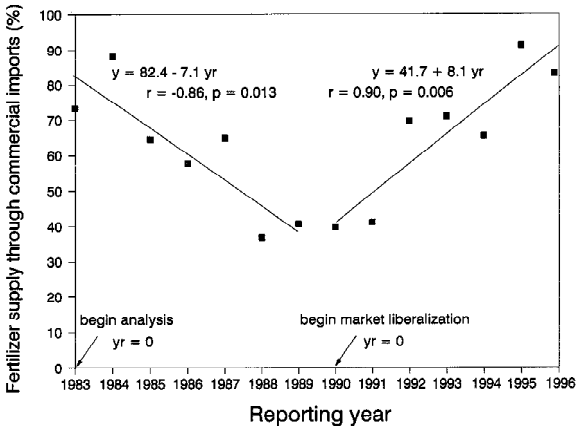

Figure 3. Commercial imports as a percentage of total fertilizer supply in Kenya between 1983 and 1996, seven years before and after initiation of marketing reforms. Note that 1983 and 1990 are equal to 0 in calculating the linear regression equations.

Discussion

Two important national indicators of fertilizer marketing, total supply and consumption, do not significantly differ when the seven years before and after onset of market reforms started in 1990 are compared (Table 2), yet other, more subtle indicators offer

promise of improvement. The large carry-over stocks resulting from distribution through parastatal agencies prior to market liberalization are reduced to 2.3×10^3 tonnes per annum, only 5% of those prior to reforms. A promising indicator of increasing private trade is the steady and significant increase in the proportion of fertilizers imported through commercial channels (Figure 3), although some 'commercial importers' are in fact reformed parastatals such as the Mumias Sugar Company and the Kenya Tea Development Authority (Schatz, 1997). During the mid-1980s, the government of Kenya actively solicited fertilizers from the international donor community for distribution through parastatal commodity and farmers' organizations resulting in a decline in commercial importation. Between 1990 and 1996, commercial imports increased from 40% of total supplies by approximately 9% per annum (r = 0.93) to 83% in 1996 when some 41 different importers were active in Kenyan markets (Schatz, 1997). The reduction in annual carry-over stocks and increase in the proportion of commercial imports are healthy trends which reflect a growing importance and efficiency of local fertilizer retailing. This observation is supported by the average number of years that retailers have been marketing fertilizers (7.6 years from Figure 2), suggesting that many retailers were attracted to fertilizer marketing following the onset of liberalization measures in 1990.

Dealers of agricultural supplies in the Kenyan Highlands are widely dispersed and stock several fertilizer forms. No local market centre was visited that did not have at least one retailer of agricultural inputs including fertilizers. The selection in fertilizer types is not well balanced, with most containing either nitrogen or nitrogen and phosphorus while few contained only phosphorus, potassium or micronutrients. Rather than stock a wide assortment of fertilizers, retailers sell the few that are in greatest demand, particularly Diammonium Phosphate and Calcium Ammonium Nitrate. This business strategy may serve to channel needed fertilizers to farmers in a cost-effective manner (from the retailers' perspective) but may place some farmers in a difficult position when potassium or micronutrients are limiting crop production.

Local agricultural suppliers in the Kenyan Highlands occupy an important role beyond retail sales within their respective communities. They provide much needed product information, repackage fertilizers into smaller sizes and in many cases, extend credit to favoured customers. Repackaging fertilizers into smaller sizes that are better afforded and transported by smallhold farmers (see Gladwin et al., 1997) is an important retail activity. It broadens the customer base and encourages informal testing of fertilizers by smallholders, which may attract them to larger purchases in the future. Retailers recognized the importance of providing information to farmers by distributing literature and making recommendations (Figure 2), in effect filling information gaps left by local extension agents (Table 4). Many retailers' recommendations are based upon written information, attendance at meetings arranged by supply representatives and testing on family farms. At the same time, there is a tendency for information to be centred around the products stocked by retailers. Despite this conflict of interest, local retailers remain a critical link in the adoption of improved agricultural technologies and efforts to achieve greater food security.

Nutrient depletion in soils of sub-Saharan Africa poses a threat to food security and social stability throughout the subregion (Smaling, 1990; Smaling et al., 1996). In response to this challenge, strategies for soil nutrient replenishment are being formulated (Mokwuyne, 1995; Sanchez et al., 1997). An important component of restoring soil fertility is the adoption of integrated nutrient management techniques (Smaling et al., 1996) which includes efficient use of chemical fertilizers applied in conjunction with farmer-available organic resources (Myers et al., 1994; Swift et al., 1994) The role of local private enterprise in promoting integrated nutrient management within large-scale nutrient replenishment initiatives is not well established (Woomer et al., 1997a). To a large extent, the requirements for fertilizer inputs depend on specific soil conditions and the availability and quality of organic inputs (Jenssen, 1993; Palm et al., 1997) Distribution mechanisms involving local retailers seem well suited to allow the fine-tuning of nutrient replenishment efforts to local conditions. Another reason to engage local retailers in nutrient replenishment efforts is to remain within the principles of free and fair markets underlying Structural Adjustment Policies (see Alexandratos, 1997).

An emerging strategy for nutrient replenishment is the replacement of soil phosphorus losses with inorganic fertilizers, which also enhances the potential for biological nitrogen fixation (Sanchez et al., 1997). East Africa is well-endowed with rock phosphate deposits (Van Kauwenberg, 1991). Phosphate from the Minjingu mine is sold at Arusha, Tanzania in 50 kg bags for US $50 per ton (Woomer et al., 1997a), equivalent to only $0.35 kg P^{-1}. In contrast, Triple

Super Phosphate imported from developed countries, shipped through the port of Mombasa and transported inland is sold for $497 per ton or $2.40 kg P^{-1}. However, the potential price advantage of rock phosphate over superphosphate was poorly reflected at the retail level. The irregular distribution and over-pricing of Minjingu rock phosphate suggest poorly developed or distorted marketing networks.

The poor distribution of Minjingu rock phosphate may reflect concerns raised by agricultural researchers in Kenya over reduced benefits in many non-acidic soils (F. Muchena, pers. comm.). Woomer et al. (1997a) compiled 559 cases in which rock phosphate and superphosphate fertilizers were compared at equal input levels in East and Southern Africa, and concluded that rock phosphate performed at 65% of the level of processed fertilizers. Given its closer proximity and lower efficiency, one would therefore expect rock phosphate to be available at a lower rather than higher unit cost compared to Triple Super Phosphate (Table 5). Similarly, the greater unit costs of Single Super Phosphate P compared to Triple Super Phosphate P reflect imperfections in fertilizer marketing.

Price distortions occur among the three most widely marketed fertilizers along the fertilizer supply 'pipeline' (Table 6). The higher fertilizer prices in more remote areas are not fully attributable to the transportation costs from suppliers in Nairobi to Western Kenya. Assuming that fertilizers must be transported 400 additional km through Central Kenya to reach Western Kenya, and that road transport costs 4.5 KSh km^{-1} t^{-1} (Mohammed Hanif, pers. comm.), transportation costs are approximately 90 KSh per 50 kg bag, constituting only 33% of the difference in price between Central and Western Kenya (Table 6). Sanchez et al. (1997) reported that high transportation costs in Africa greatly contribute to the inability of smallhold farmers to purchase fertilizers. Our findings, on the other hand, indicate that more competitive marketing has the potential to lower fertilizer prices. To some extent, reduced demand in western Kenya may be related to these higher prices.Woomer et al. (1997b) reported that only 54% of farm households in western Kenya apply inorganic fertilizers, while 83% do so in the Central Highlands.

Conclusions

The survey did not query retailers about the amounts of sales or average fertilizer purchases, in part because those interviewed were reluctant to discuss these details with strangers and we did not want to risk alienation through survey design. Another limitation of our approach is that it did not monitor the changes in prices as fertilizer passes from importers through wholesalers to retailers. As a result, we are unable to estimate the profitability of fertilizer sales. Certainly, the fertilizer 'pipeline' deserves close inspection considering the widespread shortages of fertilizer supplies (Table 4) and other market imperfections (Table 6). Fertilizer shortages do not seem attributable to taxation, as fertilizers enter Kenya duty-free and are only subject to a 2.75% clearance fee (SGS, 1997) and are no longer subject to Value Added Taxes. We suspect rather a low profitability of fertilizer sales as compared to other commodities. It may be a mistake, however, to base fertilizer transportation costs entirely on quotations from bulk transporters because many fertilizers arrive at retail locations via public or small-scale transport, as witnessed during our survey by the off-loading of fertilizers from the roofs of buses and the movement of fertilizers between retail outlets by motorcycle. Despite the limitations of our study, the importance of local retail suppliers as distributors of fertilizers in Kenya was established as well as their impact on the sale of farm inputs through providing advice and short-term credit to farmers. Furthermore, reform of fertilizer markets in Kenya appears to have been 'healthy' in that infrastructural changes have led to competitive markets (Allgood and Kilungo, 1996) rather than domination by relatively few traders and transporters (see Alexandratos, 1997). As of 1996, structural reforms had not yet led to a significant increase in overall fertilizer supplies or consumption within Kenya but rather to more effective distribution systems. Given the increased importance and growth of the commercial sector and its penetration into remote rural locations, agricultural planners in the Kenyan Highlands are well advised to incorporate the role of local fertilizer retailers into rural development projects.

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References

Alexandratos N (1997) Agricultural development in the economy-wide context: approaches to policies and strategies. Chap. 7. World Agriculture: Towards 2010, A FAO Study, pp 257–293. J. Wiley and Sons, Chichester, UK

Allgood JH & Kilungo J (1996) An Appraisal of the Fertilizer Market in Kenya and Recommendations for Improving Fertilizer Use Practices by Smallholder Farmers. USAID, Nairobi, Kenya, 33 pp

Food and Agriculture Organisation of the United Nations (FAO) (1995) FAO Yearbook 1994 Production, Vol. 45. Food and Agriculture Organisation of the United Nations, Rome, 243 pp

Gladwin C, Buhr KL, Goldman A, et al. (1997) Gender and soil fertility in Africa. In: Bursch RJ, Sanchez PA & Calhoon F (eds) Replenishing Soil Fertility in Africa, pp 219–236. Soil Science Society of Amer Special Publication No. 51, Madison, Wisc.

Harwood RR (1990) A history of sustainable agriculture. In: Edwards CA, Lal R, Madden P, Miller R & House G (eds) Sustainable Agricultural Systems, pp 3–19. Soil and Water Conservation Society, Ankeny, Iowa

Jenssen BH (1993) Integrated nutrient management: the use of organic and mineral fertilizers. In: van Reuler H & Prins WH (eds) The Role of Plant Nutrients for Sustainable Crop Production in Sub-Saharan Africa, pp 89–105. Dutch Association of Fertilizer Producers, Leidschendam, The Netherlands

Kimuyu PK (1994) Fertilizer Pricing and Marketing Reform Policy Program. USAID/Kenya, 95 pp

Mokwunye AU (1995) Phosphate rock as capital investment. In: Gerner H & Mokwunye AU (eds) Use of Phosphate Rock for Sustainable Agriculture in West Africa. Miscellaneous Fertilizer Studies No. 11, pp 100–106. International Fertilizer Development Center, Muscle Shoals, USA

Myers RJK, Palm CA, Cuevas E, et al. (1994) The synchronization of nutrient mineralization and plant nutrient demand. In: Woomer PL & Swift MJ (eds) The Biological Management of Tropical Soil Fertility, pp 81–116. J. Wiley & Sons, Chichester, UK

Okigbo BN (1990) Sustainable agricultural systems in tropical Africa. In: Edwards CA, Lal R, Madden P, Miller R & House G (eds) Sustainable Agricultural Systems, pp 323–352. Soil and Water Conservation Society, Ankeny, Iowa

Palm CA, Myers JR & Nandwa SM (1997) Combined use of organic and inorganic nutrient sources for soil fertility maintenance and replenishment. In: Bursch RJ, Sanchez PA & Calhoon F (eds) Replenishing Soil Fertility in Africa, pp 193–218. Soil Science Society of America Special Publication No. 51, Madison, Wisc.

Sanchez PA, Shepherd KD, Soule MJ, et al. (1997) Soil fertility replenishment in Africa: An investment in natural resource capital. In: Bursch RJ, Sanchez PA & Calhoon F (eds) Replenishing Soil Fertility in Africa, pp 1–46. Soil Science Society of America Special Publication No. 51. Madison, Wisc.

Schatz L (1997) The fertilizer sector in Kenya: Potential linkages to the Asian market. Presented at the IFA-FADINAP Regional Conference for Asia and the Pacific, Changmai, Thailand, 1–4 December 1997, 35 pp

Smaling EMA (1990) Two scenarios for the sub-Sahara: One leads to disaster. Ceres 126: 19–24

Smaling EMA, Fresco LO & de Jager A (1996) Classifying, monitoring and improving soil nutrient stocks and flows in African agriculture. Ambio 25: 492–496

Societé Generale du Surveillance SA (1997) Guidelines for Importers. Economic Affairs Division, Government of Kenya, 12 pp

Swift MJ, Bohren L, Carter SE, et al. (1994) Biological management of tropical soils: Integrating process research and farm practice. In: Woomer PL & Swift MJ (eds) The Biological Management of Tropical Soil Fertility, pp 209–227. J. Wiley & Sons, Chichester, UK

Van Kauwenberg SJ (1991) Overview of phosphate deposits in East and Southeast Africa. Fert. Res. 30: 127–150

Wilkenson L (1990) Systat: A system for statistics. Systat Inc., Evanston, Ill, 675 pp

Woomer PL & Muchena FN (1996) Recognizing and overcoming soil constraints to crop production in tropical Africa. African Crop Sci. J. 4: 503–518

Woomer PL, Okalebo JR & Sanchez PA (1997a) Phosphorus replenishment in western Kenya: from field experiments to an operational strategy. African Crop Science Society Proceedings 3(1): 559–570

Woomer PL, Palm CA, Qureshi JN, et al. (1997b) Carbon sequestration and organic resource management in African smallholder agriculture. In: Lal R, Kimble JM, Follet RF & Stewart BA (eds) Management of Carbon Sequestration in Soils, pp 58–78. Advances in Soil Science (Series), CRC Press, Florida

World Bank (1995) Kenya: A Strategy for Agricultural Growth. The World Bank, Washington DC, 47 pp