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Modernizing Africa's Fresh Produce Supply Chains without Rapid Supermarket Takeover: Towards a Definition of Research and Investment Priorities

by

David Tschirley, Miltone Ayieko, Munguzwe Hichaambwa, Joey Goeb, and Wayne Loescher

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EXECUTIVE SUMMARY

After a burst of enthusiasm through the middle part of this decade regarding the *supermarket revolution*, there now exists a broad consensus that this phenomenon is likely to proceed much more slowly than once thought in Sub-Saharan Africa. This is especially true in fresh produce supply chains, where both the promise and the perils of supermarket expansion have received greatest attention.

In nearly the entire continent, the so-called traditional marketing sector – open air markets, dispersed informal vendors, and traditional shops – is expected to play a dominant role in fresh produce marketing for several decades. If true, this finding has profound policy implications. Specifically, it suggests that private investment in modern, integrated supply chains cannot be relied upon to solve the multitude of problems that increasingly plague these traditional production and marketing systems over a time frame acceptable to most policy makers and donors. Public engagement, preferably through meaningful public-private partnerships and an accompanying re-definition of public and private roles, will be central to improving these systems.

This paper first reviews the evolution of thinking on the supermarket revolution in Africa and presents empirical evidence from Kenya and Zambia. It then lays out a set of stylized facts and key gaps in knowledge regarding traditional fresh produce production and marketing sectors on the continent, and closes by outlining priorities for research and for public and private investment to modernize these systems in the absence of rapid supermarket takeover.

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ACRONYMS

AFRE	Agricultural, Food, and Resource Economics
AVRDC	The World Vegetable Center
CSO	Zambia Central Statistical Office
EGAT	Economic Growth, Agriculture, and Trade Bureau of USAID
FAOStat	Food and Agricultural Organization Online Statistical Database
FDI	Foreign Direct Investment
FSRP	Food Security Research Project
GDP	Gross Domestic Product
HH	Household
ICT	Information and Communication Technologies
IPM	Integrated Pest Management
ITU	International Telecommunications Union
MSU	Michigan State University
NGOs	Non-governmental Organizations
SMS	Mobile Short Message Service (Text Messaging)
US$	United States Dollar
USAID	United States Agency for International Development

1. INTRODUCTION

Strengthened supply chains for fresh produce can improve lives in developing countries in several ways. First, because yields per unit land area can be very high, many of these crops provide the possibility for land constrained farmers to become more commercialized in their farm operations, which a robust empirical literature shows has positive effects on incomes (Larkins et al. 2008; CGIAR 2005). Second, fresh produce crops provide a wide array of opportunities to add value through packaging, canning, slicing and dicing, and production of juice, sauces, preserves, and inputs to other food processing activities. Such value added creates off-farm employment, which is a major channel through which rural households escape poverty. Finally, the nutrients in horticultural crops (particularly micronutrients, vitamins, and trace elements) can make a critical contribution to improving diets in the developing world (Willett 2001; Flores and Gillespie 2001).

Table 1 encapsulates the magnitude of the opportunities and challenges facing fresh produce sectors in Sub-Saharan Africa (SSA)[1]. Annual growth in the worldwide per capita supply of fresh produce was four times higher than for cereals between 1970 and 2000. This growth was led by China, where investments in improved technical and market information, fertilizer availability, solar greenhouses, and plastic greenhouses (FAOStat 2008; Chinese Academy of Agricultural Sciences Statistics 2008), all in response to a vast opening to market incentives and very rapid income growth, led to a tripling of per capita supplies since 1970. Yet impressive growth was not limited to China: in South Asia, East and Southeast Asia, and Latin America, growth in fresh produce supply was 2.5 to four times greater than growth in the supply of cereals. This pattern is consistent with the high income elasticity of demand for fresh produce.

Africa, alone among the major continents, saw negative growth in per capita supplies throughout this period. Yet positive income growth on the continent since 2000 suggests that growth in fresh produce supply since that time has likely also been positive, and the experience of the rest of the world suggests that, if income continues to grow in Africa and proper investments are made, fresh produce can be a major source of growth for the rural sector.

Table 1. Average Annual Growth Rates (%) in Fruit and Vegetable and Cereal Supply (Per Capita)

	Fruits and Vegetables				Cereals
Country/Area	1971-80	1981-90	1991-00	1971-00	1971-00
China	1.5	7.5	9.0	6.2	0.8
South Asia	0.7	0.8	2.5	1.2	0.5
East and Southeast Asia	3.4	0.5	1.1	1.2	0.5
Latin America and Caribbean	0.2	1.6	1.4	0.9	0.2
Sub-Saharan Africa	-0.6	-0.4	-0.1	-0.3	0.4
World	0.9	1.6	3.0	1.6	0.4

Source: FAOSTAT data 2004 and USAID 2005.

[1] Unless specifically stated otherwise, reference to SSA and Africa does not include South Africa, given the vastly more developed state of its economy compared to other SSA countries.

The objective of this paper is to begin forging a consensus regarding priorities for applied research and programmatic investment in SSA's fresh produce supply chains over the next two- to three decades. We start with an overview of these chains' current status and directions of change. Because the *supermarket revolution* has received wide attention in the professional and popular press since the early 2000s, we first review the evolution of thinking regarding this phenomenon. The review shows that expectations regarding supermarket growth in Africa have cooled considerably since the initial enthusiasm. We then show that empirical evidence from Kenya and Zambia is consistent with this changed thinking. Next, we suggest a set of stylized facts – along with important gaps in knowledge – regarding the current status and drivers of change in the continent's traditional production and marketing systems, and close by outlining priorities for research and for public and private investment to modernize these systems in the absence of rapid supermarket takeover.

2. THE EVOLUTION OF THINKING REGARDING SUPERMARKETS IN AFRICAN FRESH PRODUCE SYSTEMS

Retail modernization in developing countries and its effect on the broader food system has been an important issue since the early 1960s (Harrison et al. 1974; Goldman 1974; Riley et al. 1970), and became a major new focus of research starting in the early 2000s. The most visible banner for this new work has been the supermarket revolution. Supermarkets existed in Latin America from at least the 1960s[2], but began to grow much more rapidly in that region during the economic boom and opening to Foreign Direct Investment (FDI) of the 1990s. Growth began later in East/Southeast Asia and Central Europe, followed by selected countries of Africa (Reardon, Timmer, and Berdegué 2004). This growth, together with new procurement practices that the firms try to apply, led to a rash of studies attempting to document and anticipate the impacts of these firms on existing actors in the food system, and to draw policy implications for governments and donors.[3]

2.1. Early Expectations of Supermarket Takeover

Though distinctions are made between countries, regions, and types of food products, recurring themes in the supermarket revolution literature have been the rapid rise of supermarkets, the difficulty of smaller retailers to compete with them, the difficulty of small processors to compete with large processors for the new "supermarket market", and the urgent need to deal with the exclusion of smallholder farmers from the supermarket channel. Until recently, conditions for supermarket expansion in Africa were seen to lag but not to differ fundamentally from those in other regions of the developing world; Africa was portrayed as a later *wave* in the surge of supermarket expansion, with take-off having already occurred in East and Southern Africa and beginning in West Africa (Reardon, Timmer, and Berdegué 2004). The following quote encapsulates this view:

> "Our premise is that supermarkets will continue to spread over the (African) region … and thus their requirements will either gradually or rapidly, depending on the country, become those faced by the majority of farmers … Understanding those procurement systems … is thus a way of predicting what will be the challenges and opportunities facing farmers … *in the next 5-10 years"* (Weatherspoon and Reardon 2003; parentheses and emphasis added).

2.2. More Cautious Voices

More cautious views regarding the likely rate of supermarket expansion were expressed early in Asia, and more frequently over the past thee years in Asia, Africa, and even Latin America. Goldman, Krider, and Ramaswami (1999) identified the "persistent continued strength of 'wet markets' in Hong Kong"[4] despite that city's developed economy; they

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[2] See Schwentesius and Gomez (2002) for data on Mexico. See Harrison et al. (1974) for very early data on Brazil, Colombia, Bolivia, and Puerto Rico.

[3] For early studies on Latin America, see Reardon and Berdegué (2002) for a summary, and Alvarado and Charmel (2002), Schwentesius and Gomez (2002), Faiguenbaum, Berdegué, and Reardon (2002), Farina (2002), and Ghezán, Mateos, and Viteri (2002) for country studies. See also Reardon, Timmer, and Berdegué (2004). For Asia, see Reardon et al. (2003a); Reardon, Timmer, and Berdegué (2003b); Hu et al. (2004), and Coe and Hess (2005). For Africa, see Weatherspoon and Reardon (2003), Neven and Reardon (2004), and Neven et al. (2005).

[4] Wet markets refer to traditional open air markets.

attribute this strength to these traditional markets' adaptation to consumer shopping habits. Goldman (2000) was one of the first to identify consumers' *selective adoption* of supermarkets, whereby "consumers who regularly shop in supermarkets continue to purchase fresh food in traditional outlets"; these findings echo those of others showing continued retail diversity even where supermarkets have expanded most. In Vietnam, Cadilhon et al. (2006) anticipate strong growth of supermarkets (from a base of only 2%) but suggest, "Policy makers should not promote the 'modernization' of food systems at the expense of traditional channels, which meet important consumer needs". Maruyama and Trung (2007) also see strong growth, but cite serious challenges for supermarkets in lowering their prices and enhancing their locational convenience, both of which are key factors for the great mass of consumers in Africa and Asia.

Patterns in Latin America are relevant as a potential indicator of future patterns elsewhere. Booz-Allen Hamilton (2003) noted, "Emerging consumers infrequently shop – if at all – at large supermarkets" in Brazil, despite the heavy market penetration of such outlets in that country. They refer to "the myth (that) it's just a matter of money and time until emerging consumers flock to large supermarkets" (p. 12), and conclude in general for Latin America "small retailers have a sustainable business model". Farina, Nunes, and Monteiro (2005) echo this conclusion in Brazil, noting the persistent diversity of retail outlets, and that "the number of independent supermarkets (as opposed to large chains) and traditional retailers has grown, and their share in food sales has increased (in recent years)".

Reviewing literature on supermarkets in Africa, Humphrey (2006) concludes, "The extent of transformation of retailing … as a consequence of (supermarket expansion) is overestimated". In Kenya, where supermarkets had penetrated more than in any SSA country outside South Africa and perhaps Zambia, Tschirley, Muendo, and Weber (2004) and Tschirley et al. (2004a) estimate that supermarket chains held less than 2% of the national urban fresh produce market in late 2003, and that nearly all fresh produce purchases in these supermarkets were made by consumers in the top 20% of the income distribution. They calculate that, to reach a 10% market share in 10 years, supermarket sales of fresh produce would have to grow 22% per year in real terms. In a cross-country econometric analysis, Traill (2006) estimates that Kenyan supermarkets will hold at most a 16% share of total food sales by 2013; this would correspond to a 4%-5% share of fresh produce. Ayieko, Tschirley, and Mathenge (2006) echo findings elsewhere of diverse shopping habits among consumers, noting that 94% of Nairobi consumers frequented at least three different types of food retail outlets in the previous month. By 2007, Reardon and Timmer (2006) had noted the very small market shares of supermarkets in nearly all of SSA. They suggested "considerable uncertainty about the rate at which the supermarket sector will grow" even in Kenya and Zambia; in most of the rest of SSA, they deemed it "unlikely that … we will see supermarket growth for several decades." Echoing this, Reardon and Gulati (2008) do not include SSA outside South Africa in their table of waves of global supermarket expansion. In the most recent study, in Madagascar, Minten (2008) shows the very small market shares of supermarkets, notes that none of the global retailers has expansion plans, and suggests, "Agriculture for local consumption in poor countries will be largely bypassed by the global food retail revolution."

In India, market reform and opening to FDI, along with prospects for 7% yearly growth in retail sales in a market of 1.2 billion people, have generated billions of dollars of current and planned investment in supermarkets by local and multi-national firms, including Wal-Mart and Carrefour. Yet supermarket shares in India are currently very low (around 2%), due to the country's massive and complex small retail sector. Supermarkets there face the 20/20/20

challenge: they must grow their food sales by 20% a year for 20 years just to reach a 20% market share, still leaving 80% to more traditional channels.

2.3. Supermarkets and the Exclusion of Small Farmers

Concern about exclusion of smallholder farmers from supermarket supply channels was most acute in fresh produce, since it can be marketed directly to supermarkets by farmers. Concerns are based on the efforts of fresh produce procurement managers in supermarket chains to provide consumers with a stable, year-round supply of safe, high quality produce at competitive prices. Farmers that cannot meet these criteria, especially the need for fixed quantities every week of the year, fall off the supermarkets' *preferred supplier* lists. Smallholder farmers are especially challenged in this regard, and evidence is mounting that all but a tiny minority, whether independent or in farmer groups, are unable to remain on preferred supplier lists on a sustained basis[5]. As a result, medium- and large-scale farmers supply the overwhelming majority of fresh produce moving through preferred supplier programs in Africa.

Yet these programs carry a tiny fraction of the food trade in African countries. For example, in Kenya in late 2003, this share was less than two-tenths of one percent of all food purchased in urban areas[6]. Thus, while smallholder exclusion from large supermarket supply chains is a reality, it cannot now be considered among the top tier of rural policy concerns in this area of the world; nor is it likely to become a top tier concern over the next 10-20 years in most countries, given projected supermarket shares over this time.

[5] Regoverning Markets e-Conference 2004; personal interview with Mr. Willie Minnie, Procurement Manager for Freshmark Zambia (September 2005); Reardon and Berdegué 2002; Reardon and Timmer 2006.

[6] Based on a 2% market share by supermarket chains in fresh produce, a 20% share of fresh produce in urban consumer food expenditure, and a 40% share of preferred supplier programs in supermarket chain fresh produce procurement (the rest being purchased in traditional wholesale markets; Neven and Reardon 2004, for Kenya): 0.02*0.2*0.4 = .0016 = 0.16%

3. EVIDENCE FROM KENYA AND ZAMBIA

Outside of South Africa, Zambia and Kenya are arguably the two countries in SSA with the greatest prospect of supermarket expansion. Each has a meaningful commercial farm sector, making the supply base potentially more able to respond to supermarket requirements; Zambia is the most urbanized country in the region, putting a larger share of the population within reach of supermarkets; and Kenya's economy is the most sophisticated in the region, allowing supermarket expansion to be fueled by local investment. Yet as this section will show, each country shows exceptionally low supermarket shares, especially for fresh produce, and continued reliance on high income households to support those shares.

Data for this section come from two urban household surveys. In November, 2003, Tegemeo Institute and Michigan State University carried out a survey of 560 randomly selected households throughout low, middle, and high income areas of Nairobi, obtaining recall data on food expenditures over the previous 30 days, along with data on incomes from salaries, own business, and urban farming. In August 2007 and February 2008, Michigan State University collaborated with Zambia's Central Statistical Office (CSO) in a two round survey of 1,856 households in four cities of the country: Lusaka, Kitwe, Kasama, and Mansa. This survey used the same 30 day recall period as in Kenya, but used total expenditure rather than income as its measure of households' economic level. Lusaka and Kitwe are the two largest cities, each lying within the urbanized central arc of the country; Kasama and Mansa are smaller towns lying outside this area. Zambia's sample was designed to be representative of each city individually and of the four cities as a whole. Nairobi accounts for 43% of Kenya's population in towns and cities above 20,000 inhabitants; the four surveyed cities in Zambia account for 50% by this same measure.

Tables 2 and 3 show market shares of comparable retail channels in each country, broken down by food group. In each country, we distinguish between chain supermarkets and typically smaller independent supermarkets. This distinction is based on the idea that corporate supermarket chains are in the best position to fund rapid expansion while implementing the procurement practices, described above, that have been the focus of concern regarding smallholder exclusion from these channels. The two dominant supermarket chains in Kenya are Nakumatt and Uchumi, with competition from Tusker's and Ukwala; all are Kenyan companies. Shoprite (South African) entered Zambia in 1997 and is the dominant chain, with the more recent entry of Spar (a Dutch corporation based on a franchise model), and some competition from Melissa, a local chain with three stores. The *ka* sector in Zambia (ka means small in Nyanja) encompasses a vast array of informal retailers operating small tables and rudimentary shops outside of market places; kiosks in Kenya likewise lie outside of market places but tend to be more substantial in their construction. Dukas in Kenya and Grocers in Zambia are both small shops with electricity and plumbing, distinguished from small supermarkets by personal service retailing in which the vendor selects items for the shopper; each are long-standing features of the retail landscape in these countries.

Four points emerge from these tables. First, traditional shops, open air markets, and the informal sector (kiosks in Kenya, the ka sector in Zambia) sell most of the food in each country: over 60% in Nairobi, and over 70% in Zambia's four cities. In both cases, supermarket chains have the second lowest overall food share of all channels. Second, in both countries the market share of supermarket chains in fresh produce (fruit and vegetables) is one-third or less their share in staples and dairy; this finding is consistent with early themes in the supermarket literature, which acknowledge fresh produce as a lagging sector in

Table 2. Market Share of Various Retail Channels by Food Group, Nairobi, 2003

	Market Outlet						
Food Group	Super-market Chains	Small super-market	Duka/shop	Open Market	Kiosk	Butchery	Other minor outlets
	---------- % of total expenditure within the food group ----------						
Staples	21.0%	12.9%	49.5%	6.4%	8.1%	0.0%	2.2%
Dairy	13.9%	2.1%	55.4%	0.0%	10.8%	0.0%	17.8%
Meat	3.9%	0.4%	8.9%	11.5%	3.9%	68.4%	3.1%
Fresh Fruit & Veg.	4.4%	0.3%	0.7%	56.4%	35.7%	0.0%	2.6%
Overall	11.5%	4.8%	28.7%	18.7%	14.3%	16.7%	5.4%

Source: Tegemeo Institute/MSU Urban Household Survey 2003.

Table 3. Market Share of Various Retail Channels by Food Group, Four Cities of Zambia, 2007/08

	Market Outlet						
Food Group	Super-market Chains	Indep. Super-markets & Mini-marts	Grocers	Open Market	Ka Sector	Butchery	Other minor outlets
	---------- % of total expenditure within the food group ----------						
Staples	8.8%	2.2%	43.8%	17.7%	22.0%	0.2%	5.3%
Dairy	19.6%	4.1%	38.7%	7.8%	23.4%	3.2%	3.2%
Meat	7.1%	1.6%	5.2%	37.8%	12.8%	28.0%	7.6%
Fresh Vegetables	1.0%	0.8%	0.4%	67.6%	27.9%	0.0%	2.3%
Fresh Fruit	11.1%	1.9%	0.9%	55.7%	28.1%	0.0%	2.2%
Fresh Fruit & Veg	3.1%	1.1%	0.5%	65.5%	27.6%	0.0%	2.3%
Pulses	3.2%	1.2%	5.3%	74.6%	13.7%	0.0%	2.0%
Other	6.7%	1.6%	29.9%	17.6%	26.3%	0.0%	17.9%
Overall	7.3%	1.8%	21.8%	31.2%	21.7%	7.3%	9.0%

Source: Central Statistical Office/FSRP/MSU Urban Household Consumption Survey 2007/08.

supermarket penetration. Third, Kenya shows greater penetration of the modern sector than Zambia (despite its data being five years earlier), with small- and chain supermarkets holding a combined overall food share of 16%, compared to 9% in Zambia. Finally, results from Zambia show that supermarket shares are much higher in fruit (11.1%) than in vegetables (1%). This finding is consistent with the fact that Shoprite popularized new fruits such as apples and suggests that some of their market share may reflect an increase in the range of items and in overall consumer expenditure on fresh produce, rather than solely a capturing of share from other vendors.

Supermarkets in both countries remain heavily reliant on upper income consumers for their sales (Tables 4 and 5). In Zambia in 2007/08, two-thirds of all food sales in supermarket chains were to the top 20% of the income distribution, with the bottom 60% accounting for only 12% of sales. In both countries, even the top 20% of earners spend between twice as much (Kenya) and more than three times as much (Zambia) in traditional shops, markets, and informal locales than they do in supermarket chains.

Table 4. Overall Food Market Share of Various Retail Channels by Quintile of Per Capita Total Income, Nairobi, November 2003

Per capita income quintile	Mean per capita income (US$)	Market Outlet: Super-market Chains	Small Super-markets	Duka/ shop	Open Market	Kiosk	Butchery	Other minor outlets
		---------- % of total expenditure over 40 food items ----------						
1 (lowest)	96	2.5%	4.0%	33.9%	20.6%	19.6%	12.0%	7.4%
2	249	6.4%	5.0%	33.0%	17.4%	15.0%	16.2%	7.0%
3	436	2.8%	5.7%	34.7%	21.6%	13.4%	15.9%	6.0%
4	774	9.0%	4.3%	30.0%	19.8%	15.0%	18.3%	3.8%
5 (highest)	3,593	25.7%	4.9%	19.0%	15.7%	12.0%	18.1%	4.6%
Overall	1,027	11.5%	4.8%	28.7%	18.7%	14.3%	16.7%	5.4%

Source: Tegemeo Institute/MSU Urban Household Survey 2003.

Table 5. Overall Food Market Share of Various Retail Channels by Quintile of Per Capita Total Expenditure, Four Cities of Zambia, 2007/08

Per capita expenditure quintile	Mean per capita expenditure (US$)	Market Outlet: Super-market Chains	Indep. Super-markets & Mini-marts	Grocers	Open Market	Ka Sector	Butchery	Other minor outlets
		---------- % of total expenditure over 80 food items ----------						
1 (lowest)	256	0.8%	0.1%	21.7%	36.6%	29.9%	3.2%	7.7%
2	437	1.3%	0.3%	23.4%	35.7%	26.5%	6.2%	6.6%
3	638	2.7%	0.6%	23.5%	36.2%	21.7%	7.2%	8.1%
4	974	6.4%	1.9%	22.8%	30.0%	21.0%	8.2%	9.6%
5 (highest)	2,582	17.1%	4.1%	19.0%	23.7%	15.6%	9.3%	11.1%
Overall	977	7.2%	1.8%	21.9%	31.2%	21.6%	7.4%	9.0%

Source: Central Statistical Office/FSRP/MSU Urban Household Consumption Survey 2007/08.

Consistent with other literature on the topic, shares are substantially lower and reliance on high income consumers is higher in fresh produce than in overall food (Tables 6 and 7). In both countries, open air markets and informal vendors together hold about a 92% market share in fresh produce, with supermarket chains at 3-4%. In Zambia, over 75% of all fresh produce sales by supermarket chains were to the upper 20% of the income distribution, while the bottom 60% accounted for 8%; in Kenya, nearly 100% of fresh produce sales by chains were to the upper fifth of the income distribution.

Table 6. Fresh Produce Market Share of Various Retail Channels by Quintile of Per Capita Total Income, Nairobi, November 2003

Total Per capita income quintile	Mean per capita income (US$)	Market Outlet: Super-market Chains	Small Super-markets	Duka/sho p	Open Market	Kiosk	Butchery	Other minor outlets
		---------- % of total expenditure over all FFV items ----------						
1 (lowest)	96	0.0%	0.1%	0.2%	53.3%	42.9%	0.0%	3.6%
2	249	0.0%	0.4%	1.3%	56.7%	38.0%	0.0%	3.6%
3	436	0.0%	0.6%	0.0%	64.3%	33.9%	0.0%	1.1%
4	774	1.0%	0.1%	0.3%	59.3%	38.3%	0.0%	1.0%
5 (highest)	3,593	14.9%	0.1%	1.3%	48.9%	30.8%	0.0%	4.0%
Overall	1,027	4.4%	0.3%	0.7%	56.4%	35.7%	0.0%	2.6%

Source: Tegemeo Institute/MSU Urban Household Survey 2003.

Table 7. Fresh Produce Market Share of Various Retail Channels by Quintile of Per Capita Total Expenditure, Four Cities of Zambia, 2007/08

		Market Outlet						
Total per capita expenditure quintile	Mean total per capita expenditure (US$)	Super-market Chains	Indep. Super-markets & Mini-marts	Grocers	Open Market	Ka Sector	Butchery	Other minor outlets
		---------- % of total expenditure over all FFV items ----------						
1 (lowest)	256	0.4%	0.0%	0.2%	67.8%	29.0%	0.0%	2.6%
2	437	0.2%	0.0%	0.1%	69.4%	27.3%	0.0%	2.9%
3	638	0.7%	0.0%	0.6%	72.6%	23.9%	0.0%	2.2%
4	974	2.2%	1.1%	0.4%	63.4%	30.6%	0.0%	2.3%
5 (highest)	2,582	9.1%	3.1%	1.0%	57.7%	27.3%	0.0%	1.7%
Overall	977	3.1%	1.1%	0.5%	65.5%	27.6%	0.0%	2.3%

Source: Central Statistical Office/ FSRP/MSU Urban Household Consumption Survey 2007/08.

Regression analysis of the factors influencing the probability of purchasing an item in a supermarket chain delivers very similar results across the two countries and helps shed light on the reasons for the chains' low market shares. Controlling for household income, (which we expect to positively influence the likelihood of shopping in a supermarket chain), we expect the following:

- Owning motorized transport and a refrigerator will both increase the likelihood of such shopping due to the lesser locational convenience of supermarkets; each of these assets facilitates making fewer shopping trips and buying greater quantities each time;
- Because the vast majority of urban dwellers in Africa do not have their own motorized transport, distance to the various types of retail outlets will have an important influence on which outlets are chosen;
- More educated households will prefer supermarket chains due to greater cleanliness and convenience;
- Younger household heads will prefer supermarkets due to greater openness to new behaviors; and
- Processed food items are more likely than unprocessed to be purchased in supermarkets; one reason for this would be supermarkets' ability to negotiate attractive prices with large-scale processors.

We cannot form *apriori* expectations regarding female headedness nor the size of the household. Female headed households may prefer the cleanliness of supermarket chains, but may also put a greater premium on the locational convenience of markets and informal vendors, due to greater pressure on their time. Larger households may value the large purchases that could be made in supermarkets, but may also find it more difficult to accurately plan their needs and so value the locational convenience of the traditional sector. We also cannot form *apriori* expectations regarding the effect of city size (a variable we have in Zambia, because the survey was done in four cities). Larger cities can be expected to be the focus of most intense investment by supermarket chains and to have more high income consumers to support them. Yet locational convenience might be greater in geographically smaller cities that have one or two outlets.

In each country, we run a probit model predicting whether a household purchased a specific food item primarily in a supermarket chain over the past 30 days, controlling for general food category and for the income, asset, demographic, and distance to market characteristics

discussed above[7]. We also control for city in Zambia. Meat other than chicken is the excluded food category in each country. We separate chicken from other meat because production of the former is industrialized earlier in the development process and so may lend itself more to marketing through supermarket chains. In Zambia, we distinguish between processed and unprocessed staples and dairy, under the expectation that processed items are more likely than unprocessed to be purchased in supermarkets.

Marginal effects are presented in Table 8. Results show that, in both countries, income, owning a car, owning a refrigerator, and having a more educated household head all positively influence the likelihood of shopping in a supermarket chain. All these results were expected. Results in both countries also show that households headed by a female are more likely to use supermarket chains.

Table 8. Marginal Effects from Probit Predicting Purchase of Specific Food Items in Supermarket Chains in Kenya and Zambia

	Zambia (N=128,640; Pseudo Rsq=0.24)				Kenya (N=9,381, Pseudo Rsq=0.36)			
Variable	dy/dx	Std. Err.	P>z		dy/dx	Std. Err.	P>z	
Household (HH) per capita income ('000,000 ZKM)	0.0004	0.0001	0.00	***	0.0006	0.0001	0.00	***
HH Demographics								
HH size	-0.0013	0.0002	0.00	***	-0.0004	0.0005	0.39	
Education of HH head	0.0028	0.0002	0.00	***	0.0013	0.0003	0.00	***
Age of HH head	-0.0001	0.0001	0.26		0.0003	0.0001	0.04	*
HH is female headed	0.0119	0.0013	0.00	***	0.0301	0.0057	0.00	***
HH Assets (0/1 variables)								
HH owns a bicycle	0.0004	0.0009	0.66		------	------	------	
HH owns a motorcycle	0.0007	0.0030	0.44		------	------	------	
HH owns a car	0.0232	0.0018	0.00	***	0.0448	0.0080	0.00	***
HH owns a refrigerator	0.0247	0.0014	0.00	***	0.0549	0.0085	0.00	***
Food Categories (0/1 variables)								
Processed staples	0.0313	0.0032	0.00	***	0.1497	0.0177	0.00	***
Other staples	-0.0182	0.0007	0.00	***				
Processed dairy	0.1287	0.0111	0.00	***	0.1068	0.0238	0.00	***
Other dairy	0.0464	0.0068	0.00	***				
Chicken	0.0179	0.0043	0.00	***	0.0252	0.0211	0.23	
Irish Potato	0.0099	0.0064	0.12		-0.0122	0.0051	0.02	**
Vegetables	-0.0182	0.0010	0.00	***	0.0064	0.0063	0.31	
Fruit	0.0067	0.0021	0.00	***	0.0063	0.0072	0.38	
Pulses	-0.0040	0.0017	0.02	**	------	------	------	
Other processed food items	0.0180	0.0019	0.00	***	------	------	------	
Other food items	-0.0121	0.0014	0.00	***	------	------	------	
Distance to Markets (km)								
Distance to main public market	0.0003	0.0001	0.01	***	------	------	------	
Distance to informal vendors (ka)	0.0010	0.0004	0.02	**	------	------	------	
Distance to small grocers	0.0002	0.0001	0.10	*	------	------	------	
Distance to supermarket chain	-0.0021	0.0002	0.00	***	------	------	------	
Distance to other market outlets	-0.0001	0.0000	0.17		------	------	------	
Cities (0/1 variables)								
Lusaka (largest city)	-0.0326	0.0017	0.00	***	------	------	------	
Kitwe	-0.0103	0.0008	0.00	***	------	------	------	
Kasama	-0.0055	0.0007	0.00	***	------	------	------	
Mansa (smallest city; excluded)	------	------	------		------	------	------	

*** significant at 0.01; ** significant at 0.05; * significant at 0.10

Dependent variable: 1=item was purchased in a supermarket chain, 0=item was purchased in a different channel

[7] Results are very similar when the dependent variable is defined to include smaller independent supermarkets.

Larger households are less likely to use a supermarket in Zambia, but this effect is insignificant in Kenya. The only statistically significant result that differs across the countries regards the age of the household head: families with younger heads are more likely (as hypothesized) to use a supermarket chain in Zambia, but *less* likely to do so in Kenya. Overall, these results generally agree with those of Neven et al. (2005) in Kenya, highlighting the importance of income, education, and the ability to shop less frequently in driving use of supermarkets.[8] This analysis also strengthens findings from earlier research by showing (in Zambia) that, for a given food category, processed items are more likely than unprocessed to be purchased in a supermarket.

Two results from the Zambia analysis are new and potentially noteworthy. First, supermarket chains may have more difficulty gaining market share in large urban centers than in smaller towns. Lusaka is the largest city in the sample, followed in order by Kitwe, Kasama, and Mansa (the excluded dummy); each city dummy has a negative and significant marginal effect, with the absolute value of these effects monotonically increasing with city size. To our knowledge, this is a new finding, the robustness, drivers, and implications of which deserve further investigation.

Second, even after controlling for other factors, distance to various retail outlets in Zambia has an important influence on choice of outlet. Two findings are particularly important here. First, proximity to a supermarket chain is a more important determinant of shopping in such a chain than is proximity to other outlets in shopping in them; the marginal effect for distance to a supermarket chain is double that of the next largest outlet type. Second, the results highlight the key competitive advantage that informal vendors (the ka sector in Zambia) have in being able to locate close to buyers: the marginal effect for the ka sector, while half that of supermarket chains, is three times that of distance to the main public market, and five times that of distance to small grocers. This is the first analysis that we are aware of that analytically demonstrates the importance of locational convenience in consumer shopping decisions.

Summarizing, results in Kenya and Zambia – the two SSA countries outside South Africa with the greatest supermarket penetration to date – strongly support the more cautious view outlined above regarding supermarket expansion on the continent. Overall food shares of supermarket chains remain relatively low, shares for fresh produce are even lower, sales depend heavily on upper income consumers, and motorized transport, access to refrigeration, and locational convenience are key determinants of use. While it is likely that supermarket shares will grow across the continent over time, and while this growth may at some point be rapid in selected countries, the overall rate of growth is likely to be much slower than was once expected in some circles; this is especially so for fresh produce, the food category where supermarkets' transformational potential was most highly anticipated. This means that the so-called traditional marketing system is likely to remain the dominant center of fresh produce marketing across the continent for several decades.

This finding has profound policy implications. Specifically, it suggests that private investment in modern, integrated supply chains cannot be relied upon to solve the multitude of problems – logistical inefficiencies, deteriorating infrastructure, high product wastage, urban congestion, and food safety concerns – that increasingly plague traditional production and marketing systems over a time frame acceptable to most policy makers and donors. What's more, Africa's high rate of urban population growth means that a rapidly rising share of the population will be subject to these problems over time (see section 5). Public

[8] Neven finds car ownership insignificant, unlike our results.

engagement (not to say full public funding) will be central to any improvement in these areas. This public engagement must be based on a solid understanding of these systems, including the broad similarities they share and, crucially, the differences among them that can be the source of learning to improve performance. We now turn to an assessment of what is known about these systems, an identification of key knowledge gaps, and, finally, an outline of a research and investment agenda to address the festering problems in these traditional marketing systems.

4. CURRENT STATUS OF HORTICULTURAL SYSTEMS IN SUB-SAHARAN AFRICA

Horticulture is an exceptionally broad topic. Yet if we focus on the production and marketing of fresh produce in SSA, strong common patterns emerge out of this diversity. Smallholder farmers dominate production and marketing in most countries, but a very small share of these farmers account for the vast majority of marketed output. Data in Zambia and Kenya show that well under 10% of farmers provide upwards of 80% of all marketed fresh produce; this pattern is almost certainly repeated throughout the continent.

Production by these smallholder farmers is heavily dependent on purchased seeds, fertilizers, crop protection chemicals, and irrigation. Yet availability, cost, and knowledge of how to use these inputs constitute major barriers to participation by most farmers; these constraints also limit the yields and profits earned by those that do participate. Credit constraints to access inputs and equipment are a special problem for smallholders. Public sector research and extension capacity is exceptionally limited in most countries and so has made minimal contributions to improved farmer cultural practices that could increase yields and quality. Indeed, yield improvements in fruits and vegetables have been lower than in cereals, and productivity growth has been particularly low in SSA, where yields in vegetables have grown at an average annual rate of 0.6% against 0.7% for cereals and against the world average of 1.4% between 1961 and 2004 (Weinberger and Lumpkin 2005).

Uneven genetic quality and poor phytosanitary status of seeds is a fundamental limit to yield growth and stability in these regions. Most countries see very limited adaptive research to produce or select varieties suitable for the agro-climatic and input-limited production environments found in most of SSA. Due to deficiencies in seed production, processing technology, quality assurance, or management supervision, locally produced seeds (of both indigenous and exotic crops) are often contaminated by seed-transmitted pests and diseases, and are genetically diverse. The lack of proper storage facilities often leads to low or uncertain seed viability and vigor.

Production and marketing risks, driven by the production constraints identified above, the perishability of many of these crops, and inadequacies in post-harvest management (see below) also hinder participation by many farmers. Heavy and unpredictable pest pressure, unreliable rainfall, the possibility of substantial post-harvest losses, and enormous price variability (linked to poor information flows and lack of coordination along the supply chain) create opportunities for high returns to farmers able to control their production environment and provide steady supplies to the market – and for large losses for those unable to do so.

As discussed above, modern wholesale and retail sectors are growing in the region, but the so-called traditional marketing sector, made up of open air (wholesale and retail) markets, an array of informal retail vendors outside of market places, and small shops, continues to carry more than 90% of domestically marketed fresh produce in nearly all countries. Like India, the modern retail sector in most countries of the region faces the 20/20/20 challenge: retail sales through these channels will have to grow 20% per year in real terms for 20 years for these modern sectors to reach a 20% market share. As a result, for several decades in most countries, and longer in the poorest countries, improved performance in the traditional production and marketing system will remain tremendously important for income growth and equity objectives.

With some exceptions, the public market places at the center of these traditional marketing systems have become physically overwhelmed and managerially dysfunctional over the past 30 years. Physical capacity has not kept up with rapid urban population growth, resulting in unplanned and often chaotic decentralization of trade; wholesaling has often spread into existing retail markets without any new physical investment, while retailing has expanded into streets and informal market places. As a result, traffic congestion and lack of sanitation have become major economic and public health concerns, and conflict with city authorities, residents, and other businesses has escalated.

Soft infrastructure is also inadequate in these markets: formal market information, and grades and standards are typically absent or nascent, and active coordination upstream with farmers to regulate the flow of produce to the market is the exception rather than the rule. These inadequacies lead to enormous day-to-day and even within day price swings, with unexpected price collapses being a special problem (Mwiinga 2009). Meanwhile, the risky production environment discussed above, and the more limited geographical space over which markets can draw their supply (due to lack of cold chains and frequently poor roads) lead to sharp and less predictable patterns of seasonal price variability.

Ineffective public management of public markets has often been a key contributor to this decline; while new managerial approaches featuring greater collaboration between public- and private sectors are emerging, these face major obstacles in the form of outdated laws that limit private sector involvement, rent seeking by city authorities loathe to give up revenue from fees levied on traders, and pervasive mistrust between public officials and traders. Some also claim that strong-arm tactics by brokers and even organized criminal gangs also add costs to the system in some countries.

The modern horticultural export sector has grown substantially in some countries over the past two- to three decades, but even where such growth has been the most impressive, the volume of produce flowing through domestic and regional markets far surpasses that in modern export channels. For example, the ratio of the farm gate value of fresh produce sold into domestic and regional markets in Kenya to fresh produce exported through modern channels was between five and six in 2003 (Tschirley, Muendo, and Weber 2004); in Zambia, which in the early 2000s had a growing export sector, the ratio is at least 20:1 (Hichaambwa and Tschirley 2006). Even in Mexico, with one of the largest horticultural export sectors in the world, the domestic system is about twice as large (USAID 2005). Furthermore, quality and health standards and demands for reliability of supply are substantially higher in western markets than in local and regional markets; as a result, and despite sometimes more than a decade of donor and government support for smallholder involvement, farm production for export is dominated by large commercial farmers to a much greater extent than is production for local and regional markets, where smallholders typically predominate (Rios and Jaffee 2009; Asfaw, Mithofer, and Waibel 2009; Graffham and MacGregor 2009; Graffham, Karehu, and MacGregor 2009; Humphrey 2009).

Finally, government policy has substantial but mostly indirect effects on the sector. Direct government intervention in production, marketing, or pricing is rare, unlike the widespread direct intervention seen in cereals markets. Key areas where government policy affects the fresh produce sector include:

- legal frameworks for the establishment and management of markets that often hinder active private sector engagement and contribute to the progressive decline of public market places;

- land policies that make it difficult for potential private investors in market places to obtain the land needed for such investments;
- seed regulations that often emphasize policing over facilitation of innovation and thus inhibit the development and dissemination of new varieties through mechanisms such as Community Based Seed Production (Muendo and Tschirley 2004);
- neglect of grades and standards that could raise quality over time and improve price predictability for farmers;
- weak chemical regulations that allow internationally banned chemicals to be used by farmers frequently unaware of their negative environmental or health effects; and
- cumbersome procedures for the formalization of businesses, which contribute to the propagation of numerous small-scale informal food trading businesses.

5. DRIVERS OF CHANGE

The conditions identified above are not static. We identify four trends that will have major effects on African economies over the next two decades and briefly highlight how they will affect fresh produce systems. First, urban population is growing rapidly. Africa has the highest urban growth rate of any developing area, currently 3.7% per year and projected to remain above 3% through 2030. Urban population will grow about 170% over the next 30 years, far outstripping rural growth and pushing the urban population share above 50% (United Nationals Population Division 2007). In the past, rapid urban growth has been associated with explosive growth of low income urban settlements, which are served by the informal marketing sector. We see no reason to expect this pattern to change over the medium term. These patterns pose major challenges and also offer great opportunities to modernize African food systems; as perhaps the biggest users of public marketing infrastructure, fresh produce systems stand to be especially strongly affected by the type and effectiveness of public response to this trend.

A second trend is that SSA achieved Gross Domestic Product (GDP) growth of 4.3% per year from 2000 to 2005, implying a per capita income growth rate of about 2%. Agricultural GDP grew faster in SSA, at 3.8%, than in any other developing area except the Middle East and North Africa. Because many fresh produce commodities have high income elasticities of demand and provide broad opportunities for value added (through processing or ready to eat packaging), continued per capita income growth combined with rising populations could fuel increases in demand for fresh produce of more than 5% per year on the continent; growth would be even higher in urban areas, due to the urbanization trends discussed above.

Third, the cost of communications is falling and its reach is improving dramatically. Africa has the highest rate of growth of cell phone ownership, with the number of phones growing from 15m in 2000 to 160m by the end of 2006 (International Telecommunications Union 2007). Increasing competition among providers is leading to reduced calling costs, further broadening ownership and leading to the emergence of services such as mobile banking. Mobile Short Message Service/text messaging (SMS), because of its very low cost, is becoming an important channel for financial transactions and marketing information. These trends are not limited to urban areas: in Kenya, over half of a representative sample of rural smallholder farmers surveyed in 2007 owned at least one cell phone; one-quarter of all smallholder farm families in Zambia in 2008 owned a phone and an additional 44% had access to one; three-quarters of farmers selling fresh produce in Lusaka's main wholesale market in 2007 owned a cell phone and nearly 100% had access to one[9]. More recently, services such as M-pesa in Kenya have emerged that allow low-cost, secure, and instantaneous transfers of funds through SMS messaging; a farmer could communicate with a trader and receive payment from him for his product through an SMS, then go to one of the rapidly growing number of outlets at which he can convert the SMS message into cash. Growth rates in use of these services are likely to be extremely high, especially among commercialized farmers and traders, promising further reductions in the cost of exchange.

These numbers make it clear that cell phones now present a huge, still growing, and largely unexploited opportunity to improve timely access to technical production and marketing information for farmers and directly facilitate trade, even in the poorest countries of the world (see Aker 2008 for evidence from Niger). Such improvements would dramatically reduce

[9] All calculations for Kenya and Zambia are by author from, respectively, the Tegemeo Institute/MSU panel data set in Kenya, the Central Statistical Office/ MSU Supplemental Survey panel data set in Zambia, and from the MSU fresh produce wholesale price and quantity data set in Lusaka, Zambia.

search (including time) and other transactions costs for all farmers, regardless of the crop they grow; yet the perishable nature of most fresh produce means that the payoff to farmers in this sector should be especially large.

Finally, the recent explosion in petroleum prices and their subsequent collapse in the face of the worldwide financial and economic crises may portend a period of substantially greater uncertainty regarding the price of petroleum. If this proves to be the case, it will likely be reflected in greater variability in the price and availability of inorganic fertilizers and pest control chemicals; farmers operating in already weak input supply systems in developing countries may see their access to these items become even more uneven. Because fresh produce production is so reliant on fertilizer and chemicals, these trends could have especially negative effects in this sector. If energy prices begin to rise again, the scope for horticultural exports could be reduced and the relative competitiveness of air- vs. sea freight would be affected, with associated implications for competitive advantage across countries in this market. All in all, the international export market looks to be an increasingly complex arena in which smallholder farmers have few competitive advantages.

6. KNOWLEDGE GAPS

The discussion above highlighted robust but very broad similarities in fresh produce production and marketing systems across the continent. These patterns are an important foundation for understanding these systems, but likely hide a great deal of variation across countries and across supply chains within countries. Quantifying that variation – developing a quantitative comparative assessment of the structure and performance of these systems across a representative set of countries and crops – holds one key to identifying investments that may improve performance. We identify five areas where such quantitative benchmarking is needed.

6.1. Farm Level Production and Marketing Patterns

We know a great deal about the structure of production and marketing of food staples like maize in SSA. For example in Zambia, large-scale commercial farmers account for approximately one-third of total production but about half of marketed surplus (Haggblade, Longabaugh, and Tschirley 2009). Within the smallholder sector, about 2% of farmers account for 50% of smallholder marketed production. Smallholders are more dominant in Mozambique, but patterns within that sector are similar to Zambia, with about 5% of farmers accounting for 70% of marketed production (Tschirley, Abdula, and Weber 2006).

Fresh produce is considered by many to hold great promise for land-constrained smallholder farmers to commercialize into higher value crops, due to the very high values that can be produced per unit area of land. Yet there are reasons to expect that the structure of marketing of these crops may be even more concentrated than for food staples, due to high input costs, poor access to credit, high perishability, great price risk, and a resulting need for greater technical knowledge to be successful. For example, typical smallholder farmers producing vegetables for the market in Zambia may use five- to 10 different crop protection chemicals and four- to six different types of fertilizer on a field. Total costs for these chemicals and fertilizers on typical cropped areas can exceed US$1,000. Additional costs include piecework labor, transport, fuel for running pumps, and amortization of pumps, irrigation pipes, animal traction equipment, and other needed equipment. These costs constitute a major barrier for many smallholder farmers.

The number of different chemicals and fertilizers used highlights the complexity of the production process and the need for solid technical knowledge. Meanwhile, the great majority of African governments provide almost no extension assistance for such crops, meaning that farmers have to piece together what knowledge they can from neighbors and input dealers. Documenting the impact of these characteristics on the actual structure of production and marketing of the major fresh produce crops in SSA is the starting point for devising approaches to enhance smallholder access to these potentially very profitable markets.

6.2. Price Behavior and Information Flows throughout the Supply Chain

Comparison of price levels across countries, especially in relation to import- and export parity prices, is a standard feature in the assessment of food staple systems. Examination of the level and trends in gross margins is also common. This kind of comparative knowledge is largely lacking in fresh produce systems. In part this discrepancy is due to the greater tradability and storability of food staples. Yet fresh produce is traded regionally in Africa, so

that comparison of price levels and spatial margins across neighbors becomes important. Gross margin analysis for major crops across a range of countries would provide an important benchmark to then examine the reasons for differential performance. Price variability and predictability are also measurable performance dimensions that influence consumer and producer welfare and should be strongly correlated with the level of development of the production and marketing system (Mwiinga 2009).

The behavior of these variables is strongly related to the adequacy and efficiency of information flows in the supply chain. A signal feature of effective fresh produce wholesale markets is that they are strongly linked backwards to the farm and forwards to retailers through information flows. Traders or brokers in the market are in constant contact with farmers and buyers, packaging and quality standards are clear and adhered to, farmers have a good sense of what price they will receive when they take produce to the market (and of what they would receive in alternative markets), and traders/brokers have a good handle on the quantities they are likely to receive on a given day and what they'll be able to sell. Fluctuations in physical arrivals do occur and can drive sharp price adjustments, but extreme day-to-day price changes (e.g., of more than 20%) are the exception (Mwiinga 2009). While much of this communication takes place through private, informal communications, timely public availability of information on prices and quantities moving through markets is an important complement to these private communications. For example, brokers operating in South Africa's national network of fresh produce wholesale markets have access to real time information on transacted quantities and prices throughout the day, and daily average prices and total quantities for all grades of all products are posted on the web at the end of each day. North of the Limpopo, this type of active coordination from market to farm appears to be much less developed, and real time information on prices and quantities is nearly always lacking. Little is known about what information farmers and traders do have, about how level the information playing field is, and about what the payoff would be from improved, real time marketing information.

Price determination, and especially the role of brokers, is another key issue in this area. Many wholesale markets feature brokered transactions rather than transfer of ownership between first sellers[10] and wholesalers. This brokering activity frequently becomes a focus of suspicion among farmers and smaller traders, who often believe that brokers under-report their sales price so that the actual cost to the first seller is greater than the official commission they pay to the broker. Impacted information is simultaneously a serious constraint to good research in this area and an indicator that such research is needed.

6.3. Wholesale Market Logistics

Wholesaling facilities for fresh produce on the continent range from South Africa's national system of modern wholesale markets with strong linkages down to farm level, to more rudimentary but updated market places, and from markets that were once adequate but have failed to keep pace with rising urban populations (e.g., Wakulima market in Nairobi), to woefully inadequate locations offering almost no hard- or soft infrastructure to facilitate efficient and safe wholesale trade (e.g., Soweto market in Zambia). Assessing the benefits of upgrading existing facilities, building new facilities, and promoting coordination down to farm level requires a range of system-wide information, but needs to start with a common set of metrics regarding the performance of these market places. These include measures of time

[10] By first seller we mean anyone arriving at the wholesale market with product to sell; typically these are farmers or rural assembly traders.

and other costs for sellers and buyers, gross throughput and value added per unit area (and per unit investment) in the market, product wastage (including the typical magnitude of price decline over the course of a day, required to find a market for poor quality produce), and gross margins within the wholesale markets themselves (in many cases this involves the difficult task of quantifying formal and informal brokerage fees within these markets).

6.4. Wholesale and Retail Market Ownership and Management

Though exceptions exist, formal wholesale and retail markets in Africa are most often owned and managed by municipal authorities, with oversight from ministries of local government. Too often, relationships between the traders using the markets and these public sector authorities are confrontational. Fee structures are often not well defined, fee collection is a source of conflict, use of the funds is not transparent, and there is often little if any evidence of meaningful investment of the funds into market improvements or even basic upkeep such as trash collection. As a result, many markets have become physically overwhelmed and sources of major concern about urban congestion and public health. Innovative efforts led by private investors to build new, formally recognized wholesale markets, such as the Kasarani effort outside Nairobi in which the City Council granted 100 acres of land to potential investors, have foundered on disagreements with municipal authorities about public and private roles in ownership and management.

Yet the unplanned decentralization of markets noted in section 4, driven by the dysfunction too often seen in formal market places, has led to a greater variety of ownership and management structures, typically with much more private sector control. Documenting what these structures are, how they emerged, and linking measurable performance indicators to them could begin to provide insights as to how this often chaotic decentralization of trade can be turned to advantage in institutionalizing more effective ownership and management structures.

7. TOWARDS A RESEARCH AND INVESTMENT AGENDA TO IMPROVE FRESH PRODUCE SUPPLY CHAINS IN AFRICA IN THE ABSENCE OF A SUPERMARKET REVOLUTION

This review has argued that production and marketing systems for fresh produce in Africa are unlikely to be transformed within an acceptable time frame by private investment in modern, integrated supply chains. Public engagement is crucial to prevent the severe problems in these systems from becoming much worse in the face of rapidly growing urban populations. Experience in the rest of the world suggests that the right public policies, by catalyzing collaborative investment by government, donors, and private sector, could turn fresh produce systems into major sources of rural growth through direct production and downstream linkages in value added. In this final section we outline several areas that present major opportunities, and highlight the constraints that will need to be overcome and the research that needs to be done in each area.

7.1. Improved Information throughout the Supply Chain

The first opportunity stems from identifying ways to use the expanding ownership and falling costs of communication through mobile phones to bring a wide array of timely information to farmers and traders to improve supply chain performance. Recent research has demonstrated large improvements in market efficiency after the introduction of cell phones through their effect on reducing the cost of information needed for spatial arbitrage (Jensen 2007; Aker 2008). These improvements did not require public or donor investment: private cell phone providers invested in the systems and traders (few farmers in these cases) used the phones to search more widely and quickly for price information through their own private contacts. The challenge now, especially in light of the vast expansion of cell phone ownership among smallholder farmers over the past five years, is to find ways, when possible through public-private collaboration, to broaden the scope of information provided in this way. Examples abound:

- An SMS based system in Zambia automatically provides callers with bid price and contact information for a range of food staples in markets across the country; the system is low cost because buyers see it in their own interest to provide this information free of charge;
- An SMS system in Sri Lanka provides gherkin farmers with daily information on amount and reasons for rejection of produce in the market so that they can take immediate action on their own farms to avoid the problem (typically related to insect infestation; De Silva and Ratnadiwakara 2005);
- Another project in Sri Lanka aims to reduce information search costs throughout fresh produce supply chains through use of SMS, e-bulletin boards, price reporting screens in markets, and links with banks and extension services (De Silva and Ratnadiwakara 2005).

Examples of additional information that could be provided include input prices and availability (including seed, fertilizer, chemicals, credit, and irrigation and other equipment), early warning on pest outbreaks including best response options, technical information on recommended seeds and inputs, with the latter being conditional on specific types of production problems (this would apply especially to pest control chemicals), and including health and environmental warnings on plant protection chemicals. The key constraints to exploiting this opportunity lie in conceiving the most useful information, generating it in a

sustainable fashion, and packaging it in the most effective combination of SMS, bulletin board, radio, worldwide web, and other dissemination channels. Literacy will also be a constraint in rural Africa. Work is underway by some non-governmental organizations (NGOs) to use SMS itself to promote functional literacy for these purposes (Jenny Aker, personal communication); learning from this and other initiatives for best approaches to scaling-up needs to be a top priority.

Two points should be kept in mind as efforts move ahead to capitalize on opportunities opened up by information and communication technologies (ICT). First, the spectrum of information available through SMS systems is likely to be substantially narrower than that on local and provincial radio. Second, despite their growing adoption, issues of literacy and cost mean that cell phones are not likely for some time to be able to reach as many farmers as local and provincial radio broadcast in the local language. For these reasons, Weber et al. (2006) stress that modern ICT tools should be used, but that radio is likely to remain for some time the most effective means of "providing broad-based unbiased information to help improve the bargaining power of farmers … and in informing public decision makers about how markets function …".

7.2. Improved Production Environments

Improving production environments starts with improved crop varieties that promise larger, more diverse, and more reliable harvests. Realizing this promise then requires broader access to seed and other inputs, improved technical knowledge among farmers, and improved phytosanitary seed quality.

7.2.1. Improved Germplasm

There is a critical need for genetic resources and quality seeds adapted to the developing world production environments where many inputs, including fertilizers and water, are limited (Chrispeels and Sadava 2003). Simple screening of existing germplasm will be essential, both for performance under local conditions and management practices, and for potential under local conditions with (eventual) improved management. Yet there is also a need to develop new varieties, whether through traditional breeding or molecular techniques, both of which require considerable technical horticultural expertise.

The overwhelming importance of *exotic* species such as tomato, onion, cabbage, and kale in African diets and production systems, and the very low yields of these crops compared to worldwide norms, means that improved yields in these crops will have the largest and most immediate positive effect on farmer incomes and consumer purchasing power. Yet indigenous vegetables such as African eggplant, amaranth, nightshades, and others contribute to food and livelihood security for many resource-poor farmers (Cavendish 2000; Weinberger and Msuya 2004), have seen considerable recent growth in some countries (albeit from a very low base in terms of marketed output), and represent genetic resources and biodiversity that need to be assessed and conserved for the future (National Research Council 2006; National Research Council 2008).

7.2.2. Broader Access to Seeds and Other Inputs

Improved germplasm will do no good if farmers cannot reliably access it. It is also true that many varieties adapted to low input environments will do better with the application of fertilizers and plant protection chemicals. Post-harvest quality is also heavily influenced by farmers' ability to control pests during the production process. Improving access to seeds and other inputs requires improved credit systems, policy reform to promote private input sector development, and innovative approaches to seed propagation and dissemination such as community based seed production and other small scale seed supply micro-enterprises (learning from experience in Tanzania and elsewhere; see Muendo and Tschirley 2004).

Improved information also has a crucial role to play in improved access to credit and physical inputs. Information systems that reduce the cost to farmers of determining availability and comparing prices of inputs will lead to greater input use and higher yields; SMS-based cell phone systems are one promising approach.

7.2.3. Improved Technical Knowledge among Farmers

Use of ICT to improve information on price and availability of inputs would represent a small albeit important extension of the more common emerging use of such technology to improve information on output prices and quantities. Using the full range of ICT, including mobile phones, to improve technical information for farmers will require substantially more innovative approaches. The potential payoff to such approaches is high, because most African governments do not now and will not in the near future have the human or financial resources to operate conventional extension systems for fresh produce. Action research linked to experimental programmatic initiatives in this area, conducted in collaboration with farmer and trader organizations and input dealers, should thus be accorded high priority in future research and programmatic initiatives.

Feeding these systems with reliable information requires developing new, situation-specific information on agro ecology, sustainable production, resource management, and cropping systems, especially for environments where inputs are limited, soils are poor, or existing production practices have degraded or compromised current and future crop productivity. In addition to integrated water and nutrient management, integrated pest management (IPM) is very desirable for two reasons: (1) the presence of pesticide residues has significant trade implications, and (2) fruit and vegetable production activities are the largest users of plant protection products per hectare, and the smallholder farmers involved in this production (or poor laborers working on larger farms) rarely use protective clothing and have little knowledge of environmental risks (such as the killing crucial pollinators). Improved knowledge on proper water management approaches in dry areas is also a priority.

7.3. Improved Hard Infrastructure Linked to Better Management Models and Improved Coordination

Rising incomes and rapidly growing urban populations in Africa mean that the already deplorable state of many market places on the continent will become even worse if the accumulated deficit in hard marketing infrastructure – primarily wholesale and some retail markets with associated improvements in roads – is not confronted with urgency. Yet the planning and construction of new markets, if not informed by solid supply chain research and

carried out in a framework that ensures input from a broad range of farmers, traders, and end-users, can result in expensive new facilities that are little used and so do little to improve system performance.

Several points, therefore, need to be kept in mind as attempts are made to address the accumulated hard infrastructure deficit. First, the private sector needs to be actively engaged in the process. In some cases, private investors may be able to take the lead, with only ancillary contributions by government, e.g., making publically owned land available in a suitable location and undertaking related improvements in road access. Most often, efforts will need to proceed on the basis of public-private partnerships. Second, making a public-private partnership live up to its name will often require modifications to existing legal frameworks and accompanying attitudes. Legislation in Africa frequently gives primacy to municipal authorities in the ownership and management of market places; over time, the revenues from market fees have become important for city budgets and also the focus of rent seeking by some city officials. Conflict has become endemic, funds have not been reinvested in the market places, and the cleanliness and efficiency of market places has suffered. Finding ways to break out of this dysfunctional managerial relationship is imperative. Learning from successful examples (e.g., South Africa's national system of fresh produce wholesale markets) should be one important element in this effort.

Third, improvements in services – primarily in the amount, quality, and flow of information throughout the system – need to be conceived jointly with the hard infrastructure. This starts with the provision of real time information on transacted prices and quantities. Grades and standards developed in collaboration with the trade will improve the quality of this information and so deserve early attention. Traders often recognize differing qualities within some broad category of *standard quality* produce, so capturing this (informally) recognized heterogeneity in the form of quality grades and incorporating them into reporting of market prices and quantities can be an effective way to make progress in this area. Moving beyond prices and quantities, real time feedback to farmers on observed quality problems in the market (which can vary markedly over the season based on pest outbreaks on the farm) and technical solutions at the farm and post-harvest levels can be exceptionally useful. This kind of information properly originates in a wholesale market, which is where prices – and discounts for quality problems – are formed.

Finally, the public-private stakeholder groups that hopefully form the core of planning efforts in this area need to prioritize investment at the wholesale level. Typically, retail markets receive most attention, due to their often chaotic expansion and replication in residential areas combined with the explosion in many cities of street vendors. These are legitimate and important issues, but cannot be resolved without improvements in the wholesale markets that all these traders depend on.

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