Sustaining Farms – Sustaining Harvests

Southern African Alternatives to Industrial Agriculture

Carol B. Thompson

> When the Berlin wall was torn down and when the system of apartheid was dismantled in South Africa, two ways of thinking were reversed that had seemed intransigent only a few years earlier. (Davidson 2000: 215)

Introduction

Modern industrial agriculture runs on the principle of economies of scale. Efficient, highly automated technology produces grain in almost unimaginable yields, which more than doubled in 30 years in the United States (1955-1985: 5.7 metric tons/ha of maize to 13.3 metric tons/ha). (Swanson 1994: 39) In 1900 an American farmer grew enough food to feed seven people; today s/he feeds 96. (Heartfield 2000:319) The United States (US) is the top world's producer in maize and soya beans, and second in wheat. In all three, it is the major exporter of the crops.

Such yields are heralded as the savior of the starving masses when natural or political disasters hit other economies, from the USSR in the 1970s to Ethiopia in the 1980s or to Southern Africa in 1992 and 2002. They have been credited with assisting the post-World War II economic growth of the US, keeping food available and cheap, both necessities for family food security. They are the basis for industrial agriculture becoming the model for the rest of the world to emulate. Only with such yields can the burgeoning world population avoid the Malthusian tragedy. We have no other choice, goes the argument.

Yet the absolute numbers of hungry people continue to increase--in 2002, the estimated number is almost 850 million chronically undernourished people in the world--or about 8 percent of the total world's population. About 75 percent of the world's malnourished children live in countries with net food surpluses. (Mittel and Rosset 2001: 27) The phenomenal increases in yields over three decades and across as many continents with the Green Revolution, along with continuing hunger, question the causal link between increased yields and increased human welfare. Further, the industrial agricultural approach is not sustainable; the ever-increasing use of energy and natural resources, most often without replacement, is too high a price to pay for adding yet another bushel to the yield. The idea that improved yields will reduce hunger appears, therefore, to be a myth--a way of thinking that needs reversal.

In spite of studies that industrial agriculture is inappropriate technology for developing agriculture in

Africa (Barkin et al 1990; Berg et al. 1990), the Agreement on Agriculture of the World Trade Organization (1995), the US Trade and Development Act (2000), and the European Union (EU) Cotonou agreement advance industrial agriculture as the world model. Because implementing the WTO Agreement on Agriculture has been slowed by opposition from South countries, Africa included, the US is fostering industrial agriculture through its own trade bill. This "fast track" also seems related to the necessity of the US to promote commercial industrial agricultural products--grain, seed, fertilizer, pesticides and equipment--to stay competitive in the world market. The Cotonou Agreement allows the EU to continue high levels of subsidies for its farmers, while requiring African countries to liberalize agricultural markets.

This article will first define industrial agriculture, to remind us of the complexity of transformations involved in its fabrication of crops and ecology and in its reconstruction of production and consumption. Second, what seems ironic is that while industrial agriculture is criticized more and more in the North—by farmers, consumers and scientists--the US government is fostering it onto Africa via international trade agreements. From the perspective of US foreign policy, it is the "development" model to emulate. Third, the study, based on over a year of field research, discusses Southern Africa agricultural approaches which favor sustainability--for the small farmer and nutritional needs. Small scale farmers do have answers, with diverse alternatives to fabricated seed, fertilizer and pesticides. Such diversity is, however, antithetical to mega-profits, which need uniformity in all agricultural inputs (water, fertilizer, seed, pesticides) and outputs (monoculture of a few grains) and consumption (additives to avoid breeding crops for taste or texture). (N.B. Southern Africa is most often defined by membership in the regional organization, the Southern African Development Community-SADC: Angola, Botswana, Democratic Republic of the Congo (DRC), Lesotho, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania, Zambia, Zimbabwe.)

Debating the limitations, successes, and dangers of industrial agriculture in the North is not enough. This analysis questions the use of international trade instruments by the US to promote this agricultural model for Africa. It demonstrates the importance for debate of current US policy that claims that international markets provisioned by industrial agriculture could provide more food security in Southern Africa than small scale farms producing diverse crops.

What is Industrial Agriculture?

A definition of industrial agriculture extends well beyond the picture of immense harvesters moving slowly over vast fields of waving grain. Its promise has been overstated by the picture of a farmer in Iowa studying a computer screen inside his tractor versus the farmer in Tanzania bending yet again over a hoe. The Iowa farmer's computer is in contact with satellites to locate the position of the tractor on a digital map of the farmer's land. The computer instantaneously displays the latest data on fertilizer

and pesticide for that specific corner of the field where the tractor is located at that moment. But will it advise against using another application of fertilizer or pesticide so toxic to the ground water? Will it tell the farmer that his saved seed from an open-pollinated variety will perform over several seasons as well as the latest high tech GMO (genetically modified organism)?

Machines replacing labor power as well as small-scale management do begin the definition. Machines turn up the soil, not a hoe or animal-driven plough. Machines spread fertilizers and pesticides, sow and water seeds. Machines reap the harvests. American agriculture is not only efficient in terms of yield per hectare but also in use of labor. It is not efficient in the use of energy, however; for every calorie of food produced, 10-15 calories of fossil fuel are burned. (Perelman 2000: 329)

As early as 1965, in an address to the American Seed Trade Association, a plant breeder stated, "Industry actually has replaced the farmer as the dominant part of agriculture." (Kloppenburg 1988: 139) The reason this statement could be made is that industry was not only providing the machinery for the farms but also had taken over supply of inputs. Because machines could not be made to harvest maize without considerable loss in the yield, the maize was manufactured to accommodate the machines. Hybrids were developed to reduce lodging of (falling down) stalks, to produce ears at the same location on a stalk and to delimit the stalk height. Short stemmed hybrid wheat also accommodated the massive harvesters. Because farmer-saved hybrid seeds do not have a high germination rate, and at best can be used one more season before quality deteriorates, farmers became dependent on industry, not their own or neighbors' supply, for seed.

Plant breeding for hybrids did not address nutrition or seed quality but rather focused on plant characteristics useful for mechanization: high plant density per hectare, uniform time of maturity, fruit firmness, uniform plant size, fruit abscission, blossom abscission.

The reproduction of hybrid maize seed was originally very labor intensive, for the detassling of maize to prevent uncontrolled fertilization of hybrids was done by hand. Having to be done quickly, American industrial seed corporations mobilized vast labor reserves, first engaging prisoners of war during World War II and otherwise, hiring university students and other casual labor. After a decade of failure, in 1965, one plant breeder was finally able to sterilize female hybrid maize plants. With detassling no longer necessary for about three billion plants per year, seed corporations saved the cost of labor, but did not pass those savings on to the consumer. Profit margins rose to 20 percent. (Kloppenburg 1988: 113)

Even after the general adoption of hybrid maize in the US from about 1935, agrochemicals were used very little. But military demand during the war increased the capacity to produce nitrogen, and by 1945, fertilizer was abundant, at half the previous price. Between 1950-1980, the tonnage of fertilizer used per hectare increased by a factor of 17. (Kloppenburg 1988: 118) The ability to plant the hybrids more

densely and their bounteous growth from massive fertilizer applications encouraged growth in insect populations, requiring more pesticide use.

In order to make the uniform seed productive across many ecological zones, the ecology must adapt to the seed. This approach is another expression of industrial agriculture; not only is the seed manufactured to accommodate the machines, but ecological vagaries must be minimized through the use of irrigation, fertilizers and pesticides. Only those farmers who can purchase fertilizers and pesticides forged to be compatible with the manufactured seed can sow large fields of hybrids. Only those with ready access to water, or who can construct miles of irrigation canals can provide water exactly when required by the seed. "Just in time" production was first tested with hybrids, well before the concept hit the Japanese and American factory floor production lines; water, fertilizer, pesticides had to be applied according to the needs of fabricated seed -- or the yields were worse than the open pollinated seeds.

Breeding a plant to accommodate a machine, increasing fertilizer use because of excess capacity production of nitrogen by the military, both resulting in the necessity for increased pesticide use, serves well the profit margin of industry. In return, industry was providing large quantities of grain (e.g. maize, wheat) at cheaper market prices.

Fabricating Crops – Genetic Jeopardy

Genetic vulnerability results from planting large fields of grain with the same hybrids. The Food and Agriculture Organization most directly gives the cause of the loss of global biodiversity:

The chief contemporary cause of the loss of genetic diversity has been the spread of modern commercial agriculture. The largely unintended consequence of the introduction of new varieties of crops has been the replacement -- and loss -- of traditional highly variable farmer varieties....For example, of the 7,089 apple varieties documented as having been in use [in the US] between 1804 and 1904, approximately 86 percent have been lost. Similarly, 95 percent of the cabbage, 91 percent of the field maize, 94 percent of the pea and 81 percent of the tomato varieties apparently no longer exist. The processes of modernization and varietal replacement, well documented in the US, have now occurred in many other countries and have surely led to substantial losses of unique genetic materials. (FAO 1996: 13-14)

The US National Academy of Sciences describes genetic vulnerability as "the condition that results when a widely planted crop is uniformly susceptible to a pest, pathogen or environmental hazard as a result of its genetic constitution, thereby creating a potential for widespread crop losses." (FAO 1996: 15; Jackson 1998)

When seed suppliers prioritize profit yields through economies of scale, then they must sell large quantities of uniform seed. Variable seed, even if it suits different ecological zones, does not suit the

market. Selling uniform varieties in large quantities accrues higher profit margins, especially if the market can be global, rather than national.

The first major crop disaster, caused by genetic vulnerability, in modern agricultural history of breeding was the result of extensive planting of a few varieties of potatoes throughout Ireland. The varieties were vulnerable to Phytophthora infestans or "late potato blight," a disease which cuts off the food supply of the plant and can turn a field of potatoes into mush in 24 hours. Repeated crop failures resulted from the inability of agronomists to understand the blight in the first years, for the plant looks very healthy until late in the growing season. It does take time for scientists to understand new pests and fungi, which is why monoculture is dangerous in the first place. This gene vulnerability crisis became the Great Irish Potato Famine (1845-1849), exacerbated by the politics of the British government against the Irish.

To have total social disruption over five years from the failure of one plant emphasizes the close interaction of agricultural and political power. Poor farmers grew and ate mainly potatoes because they could survive on its relatively adequate nutrition and because the husbandry was relatively less time consuming. One hectare of potatoes yields more food of higher dietary value than any other crop; their nutritional value is second only to eggs and much greater than either wheat or beans. A tenant farmer would eat 6-7 kgs of potatoes a day, and a family of six could survive for a year on potatoes grown on less than a quarter of a hectare. (Percival 1995: 36) Alternative crops were not grown because they had neither the land nor the time as tenant farmers for large land owners.

The monoculture crop failure and British trade policy combined to cause the famine, killing over one million people and sending another million or so overseas. Ireland's population dropped from 8.2 million in 1841 to 6.6 million by 1851. (Mokyr 1983) But there was never a food shortage in Ireland. Assistant Secretary of the Treasury of Great Britain, Charles Trevelyan, blamed the hunger on backwardness and laziness of people, an attitude still too often directed toward current famine victims, whether in Africa or in North Korea. A fundamental cause of the famine was Trevelyn's (and other officials of the British government) belief that interference with the market would create more problems, again reflecting a response which is all too familiar today. The British did not ban Ireland exporting grain to England and Europe, did not ban the brewing of whiskey, and did not stop the speculation in maize meal trading, raising its price to three times the “normal” price. For every shipload of famine relief reaching Ireland, six shiploads of grain left. When criticized in the international press for not providing sufficient famine relief, the British coordinator replied, "our purchases , as I have once informed you, have been carried out to the utmost limits short of seriously raising the price in the London market." (emphasis added, Seedling 1995; Percival 1995)

Monoculture, the land tenure system, and 'free' trade are what killed the Irish and sent more than a

million overseas as refugees. With the increasing speed of technological transformation today, monoculture, combined with 'free' trade policies, could have quick and severe economic, political and social repercussions. In 1994, farmers in New York were hit by same the blight, but a more virulent strain. They suffered $100 million in crop losses and another $100 million in expenses trying to contain the disease. (Seedling 1995) Air currents can carry the infestation 10 kms. a day, and air cargoes of diseased potatoes can reach any part of the globe within 24 hours. Yet the United States still relies mainly on two varieties of potatoes for its entire crop. Industrial agriculture increases genetic vulnerability, risking sustainable long-term production.

Today the story is still unfolding about the adverse effects of the Green Revolution on biodiversity. In the pursuit of the goal of increased yields, the varieties of rice, wheat and maize available for crop production have fallen drastically. The chart below shows the pattern: from planting 2000 varieties in 1959, 5 were planted in 1991 in Sri Lanka; in India only 10 percent of the varieties still available are used in fields with high yielding varieties. And in Bangladesh and Malaysia, the vast majority of the new varieties are dependent on one parent. Such a high degree of specialization also undermines productivity; Swanson (1996: 180) also measured an increase in the average yield variability (measured as coefficient of variation) from .0.28 to 0.34 between 1960 and 1983.

Homogenization of the resource base in Agriculture

	Area in modern varieties (1000s ha)	% of rice area using modern varieties	Change in degree of specialization
Sri Lanka	612	71%	1959: 2000 varieties 1991: 5 varieties (75% from 1 maternal parent)
India	18,495	47%	30 varieties (75% of total prod using <10)
Bangladesh	2,325	22%	62% of varieties from 1 maternal parent
Indonesia	5,416	60%	74% of varieties from 1 maternal parent

Source: Swanson 1996: 149

The social harvest of the Green Revolution was to devalue peasant agriculture as inefficient and to promote monoculture as the only way to increase yields. The Green Revolution simply extended the transformation of production which occurred in the US from 1930-1960 to Asia and Latin America. I. Sachs (1987: 197) concludes, "The First Green Revolution [in the US] not only transformed agriculture into a market for industrial inputs, but also applied to food production the industrial philosophy: specialized monoculture became the main thrust of agricultural modernization, the assumption being that it would bring more efficiency."

One argument in support of increasing yields, is that if one significantly increases production, then a significant improvement in aggregate nutrition also occurs. Ryan and Asokan (1977) maintain that this outcome alone made the Green Revolution a success. Others argue that too much land was given to the grains, and insufficient amounts of pulses and other sources of protein were grown. Further, as fields are intensively cultivated the nutrients in the soil are lost and the grains themselves have less nutritional value:

The capacity of the soil to sustain productivity is reduced in over intensive cultivated areas, through a complex interaction that involves erosion of soil, degradation of physical properties, lowering of soil organic matter and plant nutrient content, reducing microbial activity, acidification of land and development of secondary nutrient deficiencies....The production per hectare is mostly flat, although the soils received an increased rate of fertilizers during the last ten years. (emphasis added, M.S. Rahman, Managing Director of Bangladesh Jamuna Fertilizer Co., quoted in Anwar 2000: 131)

Much has been written to document the adverse effects of the Green Revolution in increasing inequalities among farmers; small farmers did not have the capital to purchase all the fabricated inputs and lost out to lower market prices deriving from economies of scale. (Wilson 2000; Singh 2000) They lost not only their market niche but their land. Land was consolidated in the areas using high yield varieties, as it was consolidated in the United States as capital intensive agriculture replaced labor intensive production.

For the examples of potatoes, maize, and rice, the fundamental cause of the crises was the loss of diversity in the food crops grown. Such a high loss of diversity in the fields could signal loss of certain varieties for good, because the best conservation is to value a strain and to plant it. If a variety is totally ignored as useless, it may well disappear, even from genebanks.

Ironically, the seed fabricators must return continuously to the original germ plasm sources to retain viability of the seed. Much as manufacturers of steel must maintain a steady source of iron ore, the seed industry is very dependent on the "raw materials" of the original germplasm. They are hopeful that bacteria and other microorganisms will replace the need for the original germplasm, which is why they demanded the ability to patent microorganisms in the TRIPs (Trade-Related Intellectual Property Rights) agreement of the WTO, but that level of technology has not yet been achieved. And some

think that goal is as unrealistic and expresses as much hubris as past promises of "safe and clean" nuclear energy.

What is peculiar, therefore, is that those who depend on multiple varieties as necessary materials for manufacturing have destroyed the very material they need. This approach to making profit is not new, however, because American industry has long been allowed to destroy the environment...and move on. The following two examples illustrate hundreds that could be cited in every state of the US. At the end of the 1980s, the Council on Economic Priorities listed General Motors as the number two (after Cargill, now owned by Monsanto) toxic waste polluter in the US. GM released three times the toxic waste as Ford Motor Co. But Akwesasane peoples in up-state New York had long suffered from PCBs being dumped from the GM plants into their rivers: "Many of the families used to eat 20-25 fish meals a month. It's now said that the traditional Mohawk diet is spaghetti." (LaDuke 1999: 18, 21)

In Hawai'i, the story is similar: "It is hard to return to your traditional lifestyle when the species upon which we lived, those that fed us, have gone from the earth, forever, you cannot return. You have to go to the museum to look at the stuffed birds, but you cannot eat them. It is hard to return to our traditional practice when pesticides and herbicides toxify the food base, the land base, the food chain." (Mililani Trask in LaDuke 1999: 179) About 95 percent of Hawai'ian land is owned by 82 landholders. There are more federal hazardous waste sites in Hawai'i than in any other US state.

Kloppenburg, however, disagrees that the resource base of the Green Revolution was ignored, because institutions were established to collect and catalogue the original varieties. Instead, the original germplasm came under control of international networks of plant breeders to be saved for large scale commercial production:

The creation of the Green Revolution research centers (e.g. the International Rice Research Institute - IRRI, the International Center for the Improvement of Maize and Wheat) was the product not only of an effort to introduce capitalism into the countryside but also of the need to collect systematically the exotic germplasm required by the breeding programs of the developed nations. Western science not only made the seed the catalyst for the dissolution and transformation of pre-capitalist agrarian social formations, it also staffed an institutional network that has served as a conduit for the extraction of plant germplasm from the Third World.

Yet the end result is the same. Only a very few indigenous strains are selected for international preservation. As farmers turn to hybrids, the rich variety of indigenous strains are lost forever. Since the initial thrust of the Green Revolution, plant breeders and agronomists have begun to recognize the value of local, open pollinated varieties (OPVs) and many of the international research centers (CGIARs) now pay almost as much attention to those as to the hybrids. For example, in Southern Africa, the ICRISAT Center (International Crops Research Institute for Semi-Arid Tropics) at Matopos, Zimbabwe has developed new strains of sorghum and millets, small grains used traditionally for

semi-arid, drought-prone areas. Many strains are OPVs. (Various site visits by author, 1986-2001) As will be discussed more below, they are also assisting local, peasant farmers to propagate their own seed, helping them to avoid the escalating costs of maize seed in the region.

Reconstructing (Fabricating) the Ecology

The damage done by industrial agriculture cannot always be redeemed, although many in advanced industrialized countries act as if a technological fix can be found for any pollution problem. However, to give one example, in 1990 a study concluded that only 20 percent of the Great Plains in the US remained sufficiently unaltered to be potentially capable of ever supporting natural plant communities. The grasses are gone forever. (Rifkin 1992: 206) For every ton of grain and hay harvested in the US, 2.5 tons of soil are lost. The US Department of Agriculture estimates the cost of losing topsoil across the US at $40 billion per year. (Pyle 2002).

Perhaps the most catastrophic example, one that might rival the 1840s potato famine in Ireland, is the arsenic poisoning of water in Bangladesh (41 districts) and West Bengal (8 districts), India. (Sarkar 2000: 17) Bangladeshis were taught by development workers not to drink the surface water (the whole country is a massive delta that drains the Himalayas and the plains of northern India and southern China), but to sink tubewells for safe water; in fact, UNICEF installed such tubewells throughout Bangladesh from 1972. About two decades ago (first case in Calcutta in 1984), people started to become sick; now many have died. Thousands suffer from skin lesions and from the loss of toes and fingers. The level of arsenic in drinking water is toxic.

Similar to the Irish Potato blight about 150 years earlier, it took several years before scientists began to understand the source of the killer; this time the evidence points to the chemicals used in the Green Revolution production of grains (rice, wheat). The hybrids required high levels of both fertilizers and pesticides – highly toxic to aquifers where the chemicals lay to rest, not all running off into the ocean.

ARSENIC CONTENT OF MANURE/FERTILIZERS

Bangladesh

Fertilizer	Dry Weight mg/100 gm
Poultry manure	13.3
Cow-dung	11.2
Superphosphate	187.8

Source: Anwar, 2000: 108.

Arsenic poisoning from drinking water affects almost all systems of the body: nervous, cardiovascular, respiratory, hemopoietic (blood), and endocrine. It also can damage the liver, change the structure of chromosomes, and cause congenital malformation or still-born births. Arsenic accumulates in breast milk and therefore exposes new-borns to poisoning. (Sarkar 2000: 17-18)

By 1999, 96-97 percent of the total Bangladesh population had access to tubewells or other potable water sources, but tubewells can no longer be an indicator of "safe-drinking water" because of the arsenic poisoning. "Underdevelopment," not development, is also the result of the Green Revolution in West Bengal:

Protein and vitamins (C and A) can detoxify arsenic in the human body. Poverty, declining cultivation and production of pulses, deforestation leading to non-availability of cheap jungle leaves and fruits (which are rich sources of vitamins and minerals), therefore make the problem worse. (Sarkar 2000: 17)

By the late 1990s, low cost, locally made filters were available in many villages. They can effectively filter the water, but then, the arsenic-laden filtrate must be kept in closed containers and properly disposed of or it will continue to contaminate. Fabricating the ecology, by using large amounts of fertilizers and pesticides, without considering the long-term ecosystem consequences to a massive delta has inflicted more suffering on the poor. Scientists still do not know how to clean up the extensive river system.

In 1993, the US National Academy of Sciences issued a report that children's developing bodies and brains are very vulnerable to damage by neurotoxins present in many pesticides. With 20,000 pesticide products registered in the US, by 1996, a new law required stringent safety standards for pesticides, reducing permissible exposures unless the Environmental Protection Agency (EPA) was presented with reliable data showing no harm to children. This Food Quality Protection Act, however, gave the corporations a full 10 years, to 2006, to comply. Earlier, the EPA promised fast action on the most dangerous pesticides, including organophosphates OPs, nerve agents developed for

bio-warfare. But by 1999, the EPA restricted only two.

The US government permits disposal of hazardous waste by mixing it with fertilizers. Considered safe because of low concentrations, and ignoring potential problems from successive annual applications, most states do not require the corporations to inform farmers about contaminants in fertilizers. Some farmers report, however, tracing death of cattle to toxic fertilizer. (Perelman 2000:328)

One continues to read analyses from the World Bank or US Agency for International Development (USAID) about the "low" level of pesticide or fertilizer use in Africa as indicators of "lack of development." An average of 11 kilograms of fertilizer are applied per hectare of farmland in sub-Saharan Africa, compared with 69 kgs in South Asia, 71 kgs in Latin America and well over 100 kgs in the developed countries. (Harsch 1997) The chart below shows that even South African and Zimbabwean farmers'

average fertilizer use is less than South Asia or Latin America:

FERTILIZER USE IN SOUTHERN AFRICA - 1995

(average kg/ha)

Angola	1	Namibia	0
Botswana	9	South Africa	51
Congo, D.R.	1	Tanzania	9
Lesotho	19	Zambia	10
Malawi	31	Zimbabwe	59
Mozambique	2		

Data not available for Mauritius, Seychelles and Swaziland.

Sources: World Bank 2000; World Resources Institute 2001.

The development adage that reliance on chemicals is the only way to increase yields is simplistic and dangerous. It brings quick profits to the chemical industry and quick yields but it also harbors slow death to the environment and to children. In order to sell the chemicals, the industry must develop seeds which grow only with the chemicals. These "merchants of death" to the environment (aquifers, air, oceans) have reinvented themselves as "life sciences" industries. Five corporations account for over 70 percent of the global pesticide market: Syngenta, Aventis, Monsanto, Dupont, and BASF. (Kuyer 2000: 3). The first four also lead the world in sales of genetically modified seed and for ownership of patents on plants.

The UN Food and Agricultural Organization (FAO) found that

stocks of obsolete pesticides in Africa are five times larger than previous estimates, suggesting a "ticking time bomb." Figures released May 9, 2001 set the amount of prohibited pesticides at

100,000 metric tons. A preliminary FAO inventory of toxic sites in 39 African countries found that only 2,838 of 48,081 metric tons of chemicals reported had been destroyed, mainly because they had to be shipped to Europe for final disposal. The FAO also noted that pesticide corporations have not been forthcoming in assisting disposal. (Africa Recovery 2001: 42)

The recommendation here is to reject use of fertilizer per hectare as an indicator of agricultural development. In fact, it should be an indicator of the opposite -- the deterioration or decline of bio-resources: "Like a drug addict who loses the ability to feel normal without chemical stimulus, modern agriculture has so fried the soil that it cannot produce without larger and larger infusions of chemicals." (Pyle 2002) Intensive use of pesticides could also indicate deterioration of bio-resources. The U.S. National Academy of Sciences notes, "In a certain sense the use of pesticides on crops also reflects genetic vulnerability." (FAO 1996: 15) As will be discussed below, the farmers in Southern Africa know alternatives to fabricating their local ecological systems in order to increase yields; their approaches value diversity, not monoculture while they vary the cropping to suit the ecology, not the machines or chemicals.

Transformation of the Producers

> Why Own the Farm if You Can Own the Farmer?
>
> (Hamilton, 1994)
>
> There must be some way to come up with an agriculture
> that does not impoverish the majority of farmers.
>
> (Barkin, Batt, DeWalt 1990: 24)

From the point of view of industrial agriculture, land ownership is not a goal. The industry controls crucial inputs and the outputs, with the highly profitable value-added production occurring off farms. The large-scale farmer may be more vulnerable to "market forces" than the peasant farmer. Mechanically altering the vagaries of weather and other ecological demands (soil fertility), s/he lowers that risk only to become vulnerable to risks of the market, controlled by outsiders. Twenty years ago, one could already state in the US that "Farming has changed from a productive process that originated most of its own inputs and converted them into outputs, to a process that passes materials and energy through the farm, from an external supplier to an external buyer." (Lewontin 1982: 13) As the value of industrial inputs rose, relative to the value of land or of saved seed, American on-farm production accounted for less than 10 percent of total value of processed agricultural products. About one-third of the value comes from the commercial inputs and over half is derived from post-farm transport of produce over long distances (often over 2000 miles), storage and processing.

Because on-farm growing of food was devalued in the US, relative to post-farm processing, the terms of trade constantly turned against the farmers. The parity ratio is a ratio of two indices, the index of

prices received by farmers divided by the index of prices paid by farmers: "During the 1940s the parity ratio averaged 107.4 and fell to an average of 91.7 during the 1950s, to 81.5 in the 1960s, and averaged only 76.7 during the first three years of the 1970s." (Dorner 1979: 14) These are figures familiar to any developing country trying to find markets for its unprocessed agricultural production--whether grains, fruits or flowers. UNCTAD, for example, reports for developing countries (1999: 84-85): "There is a steady downward trend (in terms of trade) since the early 1980s....short term volatility in commodity prices has increased considerably since the 1970s....The growth of the purchasing power of exports has constantly been below that of export volumes. Income losses were greater in the 1990s than in the 1980s.(UNCTAD 1999: 84-85)

The only way to survive in this downward whirlpool spiral, where one most often ends up at the bottom, is to increase efficiency and economies of scale. One consolidates land, turns more to monoculture of a few varieties over thousands of hectares, and chooses machines over labor. Such an approach gives desired yield results but, even if one ignores the dangerous side-effects, the yields are not sustainable.

The capital intensive/labor intensive developments of the past 100 years, outlined in the chart below, virtually depopulated the US countryside, where in 1900, 42 percent of Americans lived on farms and by 2000, less than 1.5 percent.

Changes in the Composition of US Agricultural Inputs

YEAR	LABOR %	CAPITAL %	Percentage of US Workers on Farms
1870	65	17	58.9
1900	57	24	37.5
1940	41	41	17.4
1960	27	54	6.1
1976	16	62	2.7
1994			2.5

adopted from Kloppenburg 1988: 31; updated US Department of Agriculture. 2000. The World Almanac: 137.

About 32,500 farms per year between 1987-1992 were lost. (Kristof 2000) This depopulation left severe human and social problems in its wake--many of which are still not adequately addressed--from the breakdown of family (not just farm) life to fatal diseases caused by malnourished obesity from fast-food diets.

The shift in agricultural production involves more than a simple substitution of one product for another.

These processes are not socially or geographically neutral; where traditional food crops are being displaced, so too are small-scale food producers:

The effect of substitution is to undermine the livelihood of much of the rural population and to decrease the availability (and increase the price) of basic staples for the bulk of the population. This conversion process exacerbates the growing food and economic crises in developing market economies and will continue to do so unless effective policies are adopted to counteract this course. (Barkin, Batt, deWalt 1990: 24)

The suggestion here is that perhaps Southern African countries can avoid this history, for industrial agriculture is not inevitable for the vast majority of farmers in the region who remain small scale. Quite the contrary, one might say it is impossible, for industrial agriculture has become resource/energy intensive to the extent that cannot be maintained.

The struggle for land is, therefore, an economic and political struggle to eradicate economic apartheid in the region; it raises the debate whether land is to be distributed to the landless, or to already proven master farmers--whether black or white. The post-apartheid land policies are too complex and varied across the region to elaborate here; for example, the Zimbabwe government is taking land to give first as patronage to party loyalists; with the current pace, the South African land restitution policy will take 150 years to implement. (Manong 2002: 4) What is generally accepted is that severely inequitable land distribution deters development; second, the call for "willing seller-willing buyer" is not practical. As soon as the Namibian government announced that policy a few years ago, land speculation drove the prices above any logic. In the 20th century, there was no such policy for land redistribution anywhere in the world except the Republic of Ireland and Zimbabwe until 1998. In South Korea and Taiwan, the US government provided US dollars to landlords and sent US troops onto their land to encourage their departure. The struggle over land is a legacy of apartheid in the region which will take many varied policies and many years to resolve. (Thompson 2003)

The goal of the harsh and violent struggle for land in Southern Africa (e.g., Zimbabwe, Namibia, South Africa) is not to replace black for white farmers but to transform production relations. Large scale farming will continue, of course, especially for some crops. Yet there is no evidence to show that smaller scale farmers in Zimbabwe, for example, are less efficient in growing maize or soya or groundnuts. Yields of food crops do need to increase dramatically over the next decade in Southern Africa, but it is not assumed that will occur through uncritical adoption of industrial agriculture. Southern Africa is rich in skilled labor, not in capital. Southern Africa is rich in diverse food crops for its diverse ecological zones, from sorghum, millet and cowpeas to maize and rice. Labor-intensive agriculture would employ the resources available and minimize the deficit, capital. Farmers already vary production to fit natural vagaries (drought, floods). Small scale farming

could serve local and regional food needs, while capital-intensive industrial agriculture might serve overseas markets with flowers and horticultural products. Small scale farmers produce about 70 percent of Zimbabwe's maize, almost all the sorghum, cowpeas, and groundnuts. They can increase their role in soya and beef supplies.

Those corporations which sell industrial seed, pesticides and fertilizers do not need to own land, however, for they prefer to control the inputs and the marketing of the crops. Industrial agriculture has increased the ways in which value is added off-farm through the use of intellectual property rights. Since the 1980s, contract farming became an option in Southern Africa for the "successful" farmer. The contracts establish the farmer as an "independent contractor" which reduces the liability of the corporation providing a specialty seed (e.g. high oil or starch content) or requiring specific growing conditions (e.g. organic farming).

However, Hamilton's legal analysis of various American contracts concludes, "...under the language of the most contracts, the majority of risk factors remains with the farmer." (1994:61) He specifies the kind of obligations a farmer incurs by signing contracts: payment for investment needed for the specialty crop (buildings, equipment); full responsibility for crop quality, often graded solely by the corporation; direct delivery to the corporation to by-pass local markets; receiving installment payments for a crop instead of payment upon delivery. If weather has reduced the harvest, the farmer may be sued for breach of contract unless s/he buys the crop in the open market at higher prices to send to the corporation. (*ibid*., 64-66).

When accepting fabricated seed from a corporation to plant, most often used is a bailment contract, which gives full title of the seed and plant to the corporation; the grower has no rights over the seed at any time. The wording of one contract from Du Pont is revealing: "This is a Bailment contract. The parties agree that the seed, growing crops, pollen, tissues or molecular components, and the harvested crop...are solely owned by DU PONT." (*ibid*, 71) The grower, consequently, cannot give, transfer or sell the seed material. Without title to the crop, a farmer has more difficulty borrowing money and cannot participate in most US federal farm programs. The farmer has become a production worker, having lost control over production decisions. Although these contracts have been highly litigated in the US as unfair to farmers, intellectual property over seed and their progeny has been extended by the US court system; patenting (monopoly use) of plants has become a major value--added to corporate seed profits. Patenting of plants is being contested within the World Trade Organization, which has tried to universalize the US approach. (Mushita 2002)

While diversifying beyond large tracts of land, it will be interesting to see if Southern African farmers can retain control of their seed, minimize pesticide and fertilizer use, and meet demand for local, multiple varieties of food. Otherwise, small farmers in Southern Africa may finally gain viable fields, only to lose to corporate control of inputs and outputs.

Re- Constructing Consumer Tastes and Choice

Zimbabwean seed breeders (Interviews, McCarter; Mpofu; Mujaju; Sithole 2001) and the most humble farmer joke about advice from North American seed companies and USAID which ignores consumer taste preferences. The Director of the Tanzania genebank explained that global corporations can omit taste as a characteristic for which to breed: "In the US, the companies don't worry about taste; they just add citric acid and sugar to make it palatable. Here taste is basic to the processing, the method of preparation, the cooking. Each step can change the taste."(Marandu, 2001) Southern Africans still prefer certain maize varieties for their sadza, pap or ugali. Yellow maize is only to eat as "green mealies" (corn on the cob) or to feed to animals. Various varieties of sorghum are for different uses, as well as to reduce risk during a dry year. Except for maize, in Zimbabwe, over 80 percent of the seed planted is saved seed--bred for taste, resistance to drought and blight, and yield. With the increasing cost of hybrid maize seed, used extensively in small scale areas in Zimbabwe for 20 years, the government has now approved the sale of open pollinated varieties (OPVs) to reduce the costs. Those varieties can yield as much as the hybrids and are lower risk because if certain inputs are deficient, the yield decreases but does not fail.

Slow to adopt industrial agriculture ("there has been no Green Revolution for Africa"), Southern Africa is also going slow in testing genetically-modified crops. They are finding major markets not only in Europe, but in Japan and SE Asia, for their non-genetically modified maize and soya. All of the Southern African countries have signed the Biosafety Protocol and are in the process of implementing it, with the precautionary principle, through national legislation. Only South Africa is proceeding quickly with commercial growing of genetically-modified crops under Monsanto direction, without sufficient guarantees for the resource-poor farmers involved (e.g. they only learned about the 'technology fee' surcharge after the crops germinated). (Interview, Mnyulwa, 2001)

Genetically modified crops will be cautiously introduced in most of Southern Africa, after they have been scientifically proven to be safe and of value under local conditions. (Interview, Mafa 2001) For example, Zimbabwe cotton growers wanted a quick introduction of Bt cotton to reduce the number of sprayings and amount of pesticide used. Three years later, the government is still not obliging, and the growers have begun to learn of adverse qualities of the genetically modified cotton, such as growing pest resistance and lower yields under certain conditions. Zimbabwe now has a Biosafety Board which will oversee the introduction of any genetically modified crops. Reliability and risk reduction among crop varieties are valued over high yields for 1-2 years.

Industrial agriculture has not yet penetrated the majority of Southern Africa farms. That "lack of development," "backward agriculture" may well provide the future food security for the region.

Industrial Agriculture Advanced By Trade Agreements

According to US and EU policies, industrial agriculture remains the heralded model for the African continent. The single indicator used to justify the singular model is yields per hectare, which do stand at less than half of those in Asia or Latin America. Although there is increasing resistance to this model of agriculture within the US and Europe (Jackson 2002; Kimbrell 2002; Dahlberg 2001; Norberg-Hodge et al 2001; McMichael 2000) official policies especially within the US, reflect coordination of domestic agricultural policy and foreign trade policy.

The US Trade and Development Act (October 2000) is the latest legal instrument used by the US government to promote its agribusiness abroad. Section 130 of the Act, the "Study on Improving African Agricultural Practices," provides funds for American Land Grant Colleges and non-governmental organizations (NGOs) to conduct a study on "ways to improve the flow of American farming techniques and practices to African farmers." It specifies use of "modern farming equipment" and "crop maximization practices." (US Government 2000) This approach assumes that industrial agriculture is appropriate for the vast diversity of land tenure and eco-systems throughout the continent of Africa.

Many World Bank (WB) documents also promote "the introduction of modern agricultural techniques and market-oriented agriculture."(quoting the World Bank in Greenberg and Bonti- Ankomah 1997: 18) The WB position is fundamentally hostile to indigenous forms of agriculture, such as low inputs of chemicals, appropriate technology, and the use of indigenous seeds. The FAO World Food Summit in Rome in 1996 claimed that rural development is "achieved" with "agribusiness as the main engine of growth." (ibid.) This is the same conference which asserted that food security for Africa could be achieved via international trade, ignoring any goal of national or regional provision of basic foods. And that approach is still promoted in 2000 US trade act for Africa.

In order to foster the industrial agriculture approach in Africa, both the US and EU advocate "free" trade in agricultural commodities, in the WTO, the US Trade and Development Act and in the Cotonou Agreement, which is replacing the Lomé Agreement for the Africa-Caribbean-Pacific (ACP) ex-colonies of Europe. But the US and Europe have never practiced "free" trade in agriculture. Both continue to subsidize highly their own agricultural production, while admonishing the rest of the world to open markets. In 1989 before the WTO (1995), the US rate of farm subsidies stood at 25 percent; in 1999, it was 24 percent. The US does point out that during the same period, EU supports were 44 percent of gross farm receipts in 1989 and 49 percent in 1999. Canada, a highly competitive grain exporter, however, moved from 34 percent in 1989 to only 20 percent in 1999. (OECD 2000) (Support rates are reported as producer support estimates, or PSE, which indicate annual subsidies--from consumers through prices and from taxpayers through budgetary payments--to support agricultural producers. The PSE is reported as a percent of gross

farm receipts.)

The European slow reform of its Common Agricultural Policy (CAP) in spite of many trade liberalization talks (transforming Lomé into Cotonou will take until 2020) resonates throughout Southern Africa, where the most competitive commodities are agricultural. Within the EU, between 1991 and 1998, subsidies for arable crops rose from 5.5 million ECU to 18.0 million ECU, an increase of 228% (ERO 2000a: 5) In 1999, Danish Church Aid found that EU hectarage subsidies to Danish farmers growing split peas resulted in the Danish sale of pre-cooked split peas at half the price which African growers could supply pulses in their own local markets. (ERO 2000b: 23)

In the 1990s, European commitment to assist ACP agriculture declined drastically: between Lomé III (1985-90) and Lomé IV (1990-1995), the amount deployed in support of agriculture and rural development declined from 62 percent to 32 percent of total European Development Fund (EDF) aid flows. (ERO 2000a: 12) By 2000, the pattern had not changed: World Bank head, James Wolfensohn, disclosed that the EU spent US$300 billion on their own agricultural subsidies, "far in excess of its foreign aid commitments." (Herald, Harare, 26 February 2001)

The first five years of the WTO was so disappointing that President William Clinton admitted just before leaving office: "If the wealthiest countries ended our agricultural subsidies, leveling the playing field for the world's farmers, that alone would increase the income of developing countries by US$20 billion a year." During the Clinton years, however, the US spent an average of US$14 billion per year on farm support. (Guardian Weekly, UK, 18-24 January 2001) In 2002, the Bush Administration passed an even larger farm subsidy, averaging $16 billion annually.

Although the Southern African Development Community (SADC) has ratified a regional trade protocol and the goal is to reduce tariffs drastically by 2008, many agricultural goods remain "sensitive" products which will continue to be protected. SADC considers regional (not national) self-sufficiency in basic grains and pulses as a development indicator. Most years (except 1992, 2002), surplus production members can provide grain deficit members. Privileging the market over human life, as Britain did during the Irish potato crop failure, is not the approach of SADC in basic foods. SADC will not add the vagaries of a market controlled by global corporations to the region's highly variable weather as a risk factor in basic food production.

African Varieties - Sustainable Agricultural Diversity

To the surprise of many, national and international concerns related to the knowledge that resides with 'indigenous peoples' and farming communities have demonstrated a staying power and political energy that could not have been anticipated even five years ago....The discovery that a 'jungle' in West Africa was, in fact, an intentionally-developed agro-forestry system spurred the reappraisal of long-held assumptions. (Crucible Group II 2000: 72,74)

As discussed above, the US population has much to rebuild of its ecologically devastated land, water and air. In Southern Africa, much of the top soil and forests have also been removed, mainly because of over-use by resource-poor villagers, but indigenous knowledge has not yet been fully destroyed.

Southern African agricultural techniques are as varied as the ecological zones and crops, and only a few examples can be given here of the innovation, collective effort, and biodiversity conservation occurring while yields also increase. Yet the sharing of agricultural practices across the region offers general principles, readily adapted to local terrain.

The first principle of Southern African small scale agricultural policy is diversity, for crop diversity lowers risk, while industrial agriculture increases it. As Swanson (1994: 40) summarizes, "Biological diversity affords a very significant service in the form of insurance that it provides. A strategy of specialization must necessarily entail greater risk-taking. Uniform specialization at the global level would incorporate irreducible and irretrievable risks into the biological production systems."

As Irish tenant farmers became too reliant on a few varieties of potatoes, Southern Africa is probably too reliant on too few varieties of maize. Some peasant farmers are returning to production of sweet potatoes, which are more nutritious than maize, have lower growing costs, and are resistant to drought. Drought resistant sorghum can be mixed with white maize to make mealie meal, adding nutrition. The goal should not be a Green Revolution in white maize, too dependent on ample rains, but rather, a diversification of staple crops. Monoculture failures in the 20th century point to diversification for the 21st, to provide food security under changing weather conditions as well as higher levels of nutrition on the same hectarage.

Tanzania Seed Co., for example, sells every type of seed, including for small scale farmer crops. Although the US government financed American seed development and actually distributed seed free for about 70 years, current International Monetary Fund (IMF) structural adjustment programs (SAPs) require privatization of public corporations. Dr. Marandu of the Tanzanian National Plant Genetic Resources Center sees privatization as seriously affecting crop diversity: "Right now Tanzania has about 150 food crops; if the private corporations finance research, we will soon have only five. We need to focus on the so-called marginal food crops, such as bambara nuts, cucurbits (cucurbitaceae - gourds, squash), finger millet (makes excellent breakfast porridge, nutritious)." (Interview, 2001)

The 1992 Conference on Environment and Development (UNCED) was the first international conference to recognize that perhaps ever-increasing yields was not the answer to a hungry world. One of its objectives is "to reduce the need for the volume of increased food, feed and raw materials by improving the nutritional value of source crops." (UNCED 1992: 112; Bhaduri 1997) But to promote diversity over monoculture will require a reversal of thinking, not in Africa but among the governments and people of the industrial giants.

A second principle in Southern Africa agricultural policy is to value--not destroy--small scale farmers and their indigenous knowledge systems (IKS). Just as diversity can replace fabricated seed monoculture, small scale farmer innovation can also replace industrial inputs. Zero tillage, for example, is now recommended for many crops, for it disturbs the top soil less. Annual ploughing exhausts the soil humus within 10 years of the land first being opened up. As humus levels decline, there is loss of soil fertility, making it more susceptible to erosion. (Mheen-Sluijen 1996: 14) When ploughing is necessary, commercial planters have been adapted so that small implements can be drawn by animals.

According to traditional African beliefs, fertilizer spoils the soil (ibid.: 10), and that indigenous knowledge seems to be proving correct. In many Southern African countries, devaluation of currency and inability of government to afford subsidies has put the price of fertilizer out of reach of small farmers, reducing yields in the short term but provoking local initiatives to find alternatives in the long term. In Zimbabwe, for example, the cost of ammonium nitrate (AN) fertilizers increased between 128 and 141 percent from June 2000 to June 2001, mainly because it is imported and the country has a chronic foreign exchange shortage. (Daily News, Harare, 12 June 2001) Smallholder Zimbabwean farmers have been priced out of the formal fertilizer market for about seven years now. Poor farmers in poor soil regions (e.g. Mutoko, Tsholotso) are using leaf composting for fertilizer and are inter-cropping to retain nutrients. (site visits, May 2001)

An agricultural practice called integrated production and pest management uses knowledge of life cycles of pests to control their populations with appropriate crop rotation, timing of planting, and use of natural predators. It includes land preparation, water and soil fertility management, and conservation of biological diversity including natural enemies of pests. Integrated pest management emphasizes arresting the trend of increased pesticide dependence and recognizing co-existence of pests. Begun in 1993 in Southern Africa, it is in operation in Malawi, Mozambique, Tanzania, Zambia and Zimbabwe, with active field programs for maize and vegetables. (SADC 2000: 12)

A third principle is to recognize that farmers can best solve their own problems, for they are researchers, plant breeders, and seed savers in their own right. Farmer Field Schools are active in Zimbabwe and are spreading to Malawi, Mozambique, and Tanzania, with SADC officially adopting this farmer-centered, not corporate-centered, strategy for adoption of new seeds, sharing of ways to fertilize without chemicals and to reduce pesticide use. Combining research and extension, a local working group might consist of agricultural extension agents, government plant breeders and a farmers' group. In Zimbabwe, the Farmer Field Schools have also included education on HIV/AIDS. (Interview, Sithole 2001)

Small scale farmers directing research agendas has been successfully pursued in Tanzania, and the goal now is for rapid expansion of this approach. Initially targeting farmers in Arusha and Kilimanjaro

districts, the SADC/ICRISAT pilot project received 100 research requests from farmers in 1999/2000. The Northern Zonal Agricultural Research Fund (NZARF) directed the requests to relevant Tanzanian research institutes. Thirty research projects were funded, reflecting well the priorities of the farmers: improved multipurpose trees, intercropping of maize/pigeonpeas (black-eyed peas), use of local resources as mineral supplements for livestock, integration of protein-rich fodder crops, improved vegetable varieties for lowland conditions, use of indigenous cover crops to improve maize yields, screening of natural pesticides, etc. (SADC/ICRISAT 2000: 4-5) Each project was specific to a district or part of a district; there was no requirement that the research provide valid or reliable results for several districts, or a whole Tanzanian region and certainly not, for all of Tanzania.

The above three principles (food crop diversity, valuing small scale production based on indigenous knowledge, farmers solving their own problems) are not simply theoretical aspirations. They signify policies being implemented in widely varying projects throughout Southern Africa. These approaches demonstrate a reversal in thinking from industrial agriculture which re-constructs the ecology, plants, producers and consumers to fit the manufactured product of the global corporation, all with the goal of increasing profit rates. Southern Africa rejects that food production is most efficient on a world scale. As discussed above, local seed breeders, government researchers, and environmental NGOs in Southern Africa claim the opposite: indigenous and locally-improved multiple food varieties are the best food security, providing nutritious food suitable to local tastes from plants which can withstand the vagaries of local conditions and are highly adapted to interaction with local fauna.

Another reversal in thinking would be to change indicators used by development agencies and academics in the North. As analyzed above, some indicators of economic "development" simply need to be replaced. The number of wells or availability of piped water cannot indicate development, if the tapped water has lethal amounts of arsenic. The amount of chemical fertilizer use per hectare should indicate lack of development or degradation, as should reliance on monoculture for food security. If diversity of food sources were an indicator of development, a local village in Africa would be more "developed" than most American towns.

Alternatives to manufacturing monoculture are bountiful. Implementation of these alternatives is not a question of technological capacity or education, but one of politics. Insofar as the industrialized countries require their industrial agriculture approach through international trade agreements (WTO, US Trade and Development Act, EU/ACP Cotonou Agreement), developing countries, such as in Southern Africa, will find their food production determined not by choice nor need for food security nor efficiency. International trade agreements extend marketing links which serve corporate agriculture, not small scale farmers nor consumers. Contrary to policy assertions by the US, WTO and FAO, we need to debate whether global agricultural markets provide, or threaten, Southern African food security. This study suggests Southern Africa, with endemic drought now interspersed with massive

flooding under global warming, faces enough risk in food security, without adding the risk of industrial agriculture for food crops.

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