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## PROMISE AND PROBLEM IN THE DEVELOPMENT OF KENYA'S WHEAT AGRICULTURE

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The Kenyan wheat sector is unique in African agriculture. The Central and Rift Valley Provinces are perhaps the only areas in Africa which have the agroclimatic conditions necessary for successful use of modern, high-yielding, wheat varieties. Relatively large-scale farming and state-of-the-art techniques have been used throughout most of the twentieth century. Kenya has collaborated in scientific endeavors to invent and implement new mechanical, chemical and biological technology. Yet the green revolution, which transformed much of Latin-American and Asian wheat agriculture, has had a relatively minor effect on Kenyan wheat production. For example, Kenya was a net exporter of wheat throughout the late 1960's and early 1970's. By the end of the 1970's, Kenya was importing wheat to meet domestic demand.

The current paper is an historical interpretation of the promise and problems of the Kenya wheat sector over the past century. This interpretation has two objectives: 1) to present a chronology of Kenya's wheat sector over most of the twentieth century, and the events which most affected that sector; and 2) to provide insights into whether Kenya can raise wheat yields and output to levels achieved in other developing countries, and if the government should actively pursue such a target.

Wheat is grown in the cooler and medium-rainfall regions of Kenya at elevations over 5800 feet sea level covering the Nakuru, Uasin Gishu, Trans Nzoia and Narok districts. Over 80% of the wheat is produced on large-scale, mechanized farms. Wheat occupies only

about 2.2 percent of the total area under crops and pasture and contributes almost the same fraction to agricultural product. The crop ranks tenth in value per hectare, with coffee ranking first and maize twelfth. Projections to the year 2000 suggest that the degree of self-sufficiency is likely to decline if demand is not curtailed. Yet wheat is still one of the seven crops that the government considers as central to achieving the development goals established for agriculture; subsidiary to these goals is the objective of wheat self-sufficiency.

## II. A BRIEF CHRONOLOGY OF KENYAN WHEAT

Following a brief description of Kenyan wheat from colonial establishment through World War I (1895 to 1920), this section proceeds with a chronological description of the major trends in wheat yields, area and output during the period from 1921 to 1990, and presents interpretations of the causes of these trends.<sup>2</sup>

### *Colonial Establishment through World War I: 1895-1920.*

Until the nineteenth century, only the coast of East Africa had attracted alien powers, including the Persians, Portuguese and Arabs. At the end of the last century, Britain and other European countries became interested in East Africa for three reasons: to safeguard the route to India, to forestall any other power which might exploit any wealth the area might have, and to help stop slavery.

Kenya and Uganda were declared British protectorates in 1895. To exploit Uganda's high, agricultural-export potential, the British constructed a railway from Mombasa on the Kenyan coast to Kisumu on Lake Victoria. Financing for the continuing costs of the protectorates and railway was obtained by European settlement in the temperate, fertile

regions of the highlands, what are now the Central and Rift Valley Provinces of Kenya; and the building of an export trade based on the exploitation of African labor on European farms and estates. Wheat was a central commodity in the establishment of colonial agriculture and an export trade.

Three types of government intervention figure prominently in the history of Kenya wheat: land tenure policies; marketing and price interventions; and public, agricultural research. During the period of colonial establishment, the British government and settler farmers established institutions responsible for government policies in these areas, and established policy directions that would remain in place for one-half century or longer.

Land tenure policy consisted primarily of reallocating property and usufructuary rights to settlers. The first twenty years of settlement focussed on the Nakuru region. Experimental production of wheat by the Church Missionary Society started in 1895 in Machakos. In 1904, Lord Delamere, a pioneer farmer, began commercial production of wheat; in 1906 he began the first, large-scale, wheat farm, with 1200 acres planted. Between 1905 and 1914 over four million acres of land were alienated from Africans to Europeans. Although most of this land was held for speculative purposes and not farmed immediately, by 1920 over 12,000 acres were planted to wheat, establishing the commercial viability of the crop. Most of the wheat output went to feed the urban populations in Mombasa and Nairobi (1909 population of 4950).

In the first two decades of the 20<sup>th</sup> century, Lord Delamere promoted wheat almost single handedly, and helped to introduce the marketing institutions that would dominate the Kenya wheat sector for the rest of the century. In 1907, he represented wheat farmers on the inaugural legislative council, given the responsibility for economic policy by the British

government. In 1919, settlers won the right to elect representatives to the council. In that same year, the settlers established the British East Africa Maize Growers Association, which evolved into the Kenya Farmers Association four years later.

In 1908, Lord Delamere, with the assistance of a few other farmers, registered Unga Ltd, which with the Kenya Farmers Association grew to become the most important wheat production and marketing agency in Eastern Africa.

Formal agricultural research was institutionalized with the establishment of the Department of Agriculture in 1903. The Department organized the first experiment station, the Scott Agricultural Station (SAS), at Kabete, three miles west of Nairobi. The SAS was to become a major research and information-dissemination center, dealing with almost all the commercial crops grown in the colony, including wheat, maize and coffee. In response to the 1908 devastation of his wheat crop by yellow rust (*Puccinia glumarum*), Delamere hired the first wheat breeder.<sup>3</sup> Delamere established a wheat experimentation center in Njoro, 120 miles west of Nairobi, in what was then considered the most suitable area for wheat production.<sup>4</sup> The breeder, G.W. Evans, found some success by crossing the Italian variety Rieti with the Australian varieties commonly imported by the settlers. Unfortunately, Evans died in 1914; his work was continued on a part-time basis during World War I by W. J. Dowson.<sup>5</sup>

In 1911, the government took over wheat research and moved the program to the SAS; this type of strong government involvement would characterize the history of Kenyan wheat research and technology policy. Another example of involvement from this early period is the government purchase in 1917 of a threshing machine. This machine was towed about by oxen for communal use until 1955.<sup>6</sup>

Kenya was transformed from the East African Protectorate to a crown colony in 1920, and the settler economy was firmly ensconced. From then on, the economic history of the colony, and agriculture in particular, was to be shaped by the opposing desires of the British government, intent on retaining the colony as a key imperial point, and the settlers' push for full economic and political control.

*The Post-World-War-I Period: 1920-1929.*

The period from 1920-1928 is characterized by an increase in area planted to wheat of over 500 percent, from 5547 hectares (ha) to 33595 ha, due to continued colonization and farming of alienated lands. Yields were fairly constant over the period. Output changes mirrored area planted, increasing from 3357 metric tons (t) to 20,712 t, also over 500 percent. Increases in the area planted to wheat are attributable to the continued colonization of the highland areas, and the growing government support for wheat production.

Previously established land tenure, marketing and research institutions blossomed in the 1920's, firmly entrenching colonial agriculture. World War I had reinforced the importance to Britain of safeguarding the route to India. The need to provide employment for returning soldiers led to continued alienation of land from Africans who were increasingly relegated to reserves consisting mainly of low-potential agricultural land that the settlers did not want. Extension of the railway in 1922 to Uasin Gishu and in 1926 to Trans-Nzoia provided settlers with easy access to additional, high-potential land. By the end of this phase of European settlement, the White Highlands encompassed over 16,000 square miles, about one-half of the high-potential, agricultural land in Kenya.

The development of marketing policy was driven by the world recession from 1919 to 1922. In 1921, the colonial government responded to the low, recession prices for Kenyan exports by appointing the Browning Committee to protect and promote European production of a wide range of crops, including wheat. The Committee introduced producer-price supports, imposed an *ad valorem* tariff of 18 to 32 percent tariff on wheat imports, and supported legislation to restrict the marketing of produce grown by Africans. Thus began the creation of state-protected monopolies for the production and marketing of particular commodities.

Following the 1922 railway extension, the settlers in Uasin Gishu formed the Plateau Maize Growers Association (PMGA), enacted legislation requiring all wheat produced in the area to be sold through the association, and constructed a wheat mill. In 1927, the KFA merged with the PMGA. This centralized the marketing arrangements for all settler, farmers to the north and west of Nakuru. During this same period, Kenya Grain Mills Ltd. was incorporated in Nairobi, and the Wheat Growers Association was formed. In 1926, as per an earlier agreement with the Browning Commission, Lord Delamere transferred control of Unga Ltd. to the wheat growers. In 1928, Unga acquired a controlling interest in Kenya Grain Mills. Since the KFA represented most of the settler, farmers, this effectively gave the KFA monopoly power.

Wheat research activities were concerned largely with establishing the institutional capacity to develop a commodity-specific research program. The primary objective of wheat research was the development of rust-resistant varieties suitable for the agroclimatic conditions faced by settler farmers. 1920 marked the release of Equator, which is apparently the first new variety developed in Kenya. In 1921, the government hired a full-

time breeder, G. J. L. Burton, to work at the SAS. Burton developed the variety Kenya Governor for release in 1925, but in 1926 mutating rusts began to attack it.<sup>7</sup> In 1927, the National Plant Breeding Station was established at Njoro, near Nakuru, to serve the large scale wheat farmers in the Rift Valley. Wheat breeding activities at the SAS were transferred to Njoro. The establishment of a research-institutional structure was accompanied by funding increases: real wheat research expenditure doubled from K£ 7758 in 1921 to K£ 15,596 in 1928. An improved, rust-resistant variety, Kenya Droop, was approved for release in 1929.

*The Depression Era: 1930 to 1939.*

The depression was the least auspicious era for Kenyan wheat. In addition to rapidly falling world wheat prices, the latter part of 1929 and all of 1930 witnessed a locust devastation of wheat and the onset of drought. Yields hit their nadir in 1931 and 1932, area planted declined by more than one-half between 1928 and 1932, and the 1932 production of 5742 t was less than one-quarter of 1928 production. While yield, area and output recovered somewhat in the following seven years, previous highs were not attained in the depression era.

Low yields and world wheat and maize prices that were one-half of the 1930 levels placed the settler community in financial jeopardy. Many settlers were shipped backed to Britain as distressed British subjects. Those that remained lobbied for and received increasing government subsidization and market protection, based on the premise that

it is the policy of this government supported again and again by the imperial government, that the highlands of Kenya shall be reserved for the ownership and occupation of white residents only ... We have established the fact that we have rights

in the area known as the highlands, and we have not...the slightest intention of giving up those rights or having them interfered with... (Kenya Colony, 1936)

Strong government intervention allowed for the mild recovery that occurred in the latter part of the 1930's.

Land tenure policies continued to reflect white ownership of alienated land. The 1939 legislative council order, officially proclaiming expanded boundaries for the white highlands and established the settler-controlled Highland Board, which had power over all land transactions within the boundaries. No African, Indian or Colored person was allowed to buy or lease land in the white highlands. Consequently, 2000 settlers and their families controlled almost one-half the arable land. Four million Africans were congested in the other one-half.

The result of the congestion in the African reserves was soil degradation, and decreasing labor and land productivity. This led to a deterioration of the nutritional situation among Africans, to the extent that by 1939 many of the Africans were under or malnourished. Reports indicate that common among the Kikuyu were bony deformities, dental problems, anemia, pulmonary conditions and tropical ulcers. Tubercular infection was widespread throughout the colony.<sup>8</sup>

The expansion and bureaucratization of government marketing interventions in the depression era began in 1930 with the Sale of Wheat Ordinance. This ordinance marked the advent of statutory control of local wheat marketing:

...the governor shall appoint an agency and no wheat grower shall sell any wheat to any person other than the agency. Any person carrying on a business of a miller shall register himself as a miller. The agency is permitted to sell wheat only to registered millers (Kenya Colony, 1930).



The official, appointed agency was the KFA. The KFA was also given sole autonomy to import wheat in case of a domestic shortfall, meaning that competing mills had to purchase imports from the KFA. This effectively entrenched the KFA's monopoly power in the wheat market. By 1938, Unga Ltd., and hence the KFA, milled 90 percent of Kenyan wheat.

Research continued to focus on wheat breeding, primarily for rust resistance. Despite a modest decline in real research funding, ten new wheat varieties were released. However, the impact of these varieties was swamped by the depression and marketing policies.

*World War II and Recolonization: 1940 to 1954.*

The area under wheat expanded rapidly from pre-war levels of around 22,000 ha to 140,196 ha in 1955 and output rose more than five-fold from about 20,000 t in 1939 to 111,987 t in 1955.<sup>9</sup> Yields fluctuated during the period, rising to a peak of 1.24 t/ha in 1950, but declined to less than 0.8 t/ha in 1955. On average, yields were 0.10 to 0.20 t/ha higher than during the depression era.

World War II and the consequent disruption of world agriculture caused the world, wheat price to triple between 1942 and 1947. As production increased, Kenya became a net exporter of wheat from 1944 to 1952. In 1953, the world price of wheat began a long decline.

During World War II, the British government promoted Kenyan agriculture as part of the war effort. Guaranteed prices and returns per acre, continued marketing control and other policies were set in place to help settlers and to increase food production for troops. For example, in 1942, under the Increased Production of Crops Ordinance, farmers were given grants of Kshs 20 and Kshs 30 per acre in case the farmer grew wheat on virgin land

and used heavy machinery, respectively. Income subsidization of settler agriculture became firmly entrenched during the war years.

The post-War agricultural-policy environment was characterized by recolonization, and by continued, government, marketing intervention. In 1945, the Development and Reconstruction Authority funded some £15,586,000 to be spent on reconstruction and development, of which 41 percent was to go to agricultural development. In 1946, there was a new wave of colonial settlers. While the Ten-Year Development Plan of 1946 gave greater consideration to African farmers, and placed requirements on new settlers such as taking a course at Egerton Agricultural College, white-settler access to high-potential lands continued. The new settlers became the major wheat growers in Post-World War II era in Kenya.

Research institutions were set up by the British Colonial government after World War II to strengthen agriculture in the whole of East Africa. This was done under the auspices of the East African Services Organization, set up in 1948. This represented a mild departure from the prior, colony-oriented institutionalization, although Kenyan research services continued. Research activities continued to be focussed along commodity lines.

*Pre-Independence: 1955-1962.*

The eight years preceding independence were relatively uneventful. Area declined slightly, yields continued a very slow upward trend, and output was relatively stagnant.

Land tenure policies were put under pressure during this period. Africans became increasingly vocal in their demands for sufficient land to earn a decent living. The Swynnerton Plan of 1954 and its implementation over the next eight years signalled a

change, with increasing attention being given to African agriculture. The plan's land tenure component subdivided the land in the reserves for free-hold titles, and through research and extension tried to increase output on these small farms to support the average African family. However, no significant changes in land-tenure policies for the white highlands were implemented prior to independence.

By 1960, almost all the arable land in Kenya was occupied, except for small pockets like the highland regions of Narok, inhabited by the Masai cattle-herders. Since the Masai did not have the formal titles to their land that would be recognized in the British legal system, settlers were able to impose share-cropping agreements on the Masai. Because of the Masai's inexperience with colonial contracting mechanisms, the informality of the contract meant that the share going to the Masai was arbitrary, and they were underpaid.

Marketing policies continued to insulate Kenyan settlers from the declining world wheat price, and to propagate monopoly power.

Kenyan wheat research expenditures increased by an order of magnitude over the previous period: real research expenditures reached their historical high in 1961. The increases went mostly to investments in land, laboratories and facilities, and fluctuated from year to year depending on capital purchases. This period also saw continued increases in varietal releases, with an average of six new releases per year.

*Independence and Re-Institutionalization: 1963 to 1968.*

Kenya achieved independence in 1963. In the first few years after independence, production, yields and area each grew rapidly, leading to production in 1968 that was more than double that of a decade earlier.

In 1963, the new Kenya government became pre-occupied with the transfer of large chunks of land to the land-hungry Africans. For example, the government stopped share-cropping among the Masai in 1966, granting usufructuary rights to the Masai. Much of this area was planted to wheat. European land-tenure rights were also renovated: large farms were bought and split into small holdings which were given to African settlers; individual Africans bought and operated former European farms, and some large farms were transferred intact to the Agricultural Development Corporation (ADC) and operated as single commercial units. In the process, the area under wheat expanded by 70,000 ha.

Transfer of land to Africans had negative effects on wheat production. First, those Africans who took over large, mixed farms either as individuals or companies didn't have any experience in wheat farming. Second, most of the mixed farms bought through companies or co-operatives were subdivided "illegally" to members. These subdivisions made it unprofitable to grow wheat, since available techniques and machinery were designed for large-scale production. To insure acceptable farm incomes, government support of wheat producers increased through 1968.

After independence, the Wheat Board of Kenya was given expanded, executive powers over planning and control of wheat and wheat-feed (bran, pollard) transport, storage and marketing; and delivery of imported and domestic wheat to millers. The KFA remained the dominant force in the milling industry. Policy interventions continued to provide implicit and explicit subsidization of wheat.

At independence, Kenya inherited well-established, agricultural-research institutions. These institutions were sustained throughout this period, but there was a sharp decline in funding from 1963 to 1965, as the colonial government pulled out of the country. Real

research expenditures recovered in the next years, reaching a new high in 1968. In 1967, agronomic research was institutionalized as a part of the wheat-research program. The research objective was to develop packages of agronomic practices, including tillage and soil-moisture-conservation practices, soil fertility control, weed control through efficient cultural practices and herbicides, and farm management and record-keeping practices.<sup>10</sup>

*Policy Indecision: 1968 to 1977.*

Output during 1968 was a record 225,355 metric tons, 39 percent higher than in 1967 and 60,000 metric tons above East African requirements. This led the government to believe that production was expanding too rapidly, and consequently they lowered producer and consumer prices. Area planted declined sharply in response, and has never reattained 1969 levels. From 1968 to 1977 yields stagnated, so that output declined with area in the late 1960s and recovered somewhat in the mid 1970s.

Throughout this period, the new government struggled to determine what policies it should pursue, and changed policies in response to fluctuations in wheat output. Due to mismatched producer and consumer prices, by 1971 demand exceeded supply and the Wheat Board had to import 59,500 t of wheat during 1972 to supplement local supplies. This was the start of Kenya's continuing dependence on imported wheat to meet domestic demand. The need to import wheat caused the government to rethink its policy, and once again encourage expansion of area planted. Efforts were again directed towards increased area under wheat in Masailand (Narok), the very region in which wheat production had been discouraged only three years earlier. Through 1977, the Government continued to

encourage wheat production through research, financial assistance, and improved storage and handling facilities.

Since Kenya became a net importer of wheat in 1973, it has benefitted significantly from concessionary wheat programs and food aid. Kenya also became a coordinating center for food aid to the war-torn neighbors of Ethiopia, Sudan and Somalia. Increasing population and urbanization and regular shortages of maize in urban areas led to growth in the demand for wheat of almost seven percent per year. Kenya has become increasingly dependent on food aid and other imports to meet this demand: by 1977, wheat imports equalled 50 percent of domestic production.

*The Moi Government: 1978 to Present.*

During the first two years after Moi became President of Kenya, wheat area and output declined substantially. Area has since recovered and surpassed 1977 levels, but has not regained peak levels of the late 1960s. Yields increased during the first four years of the Moi presidency. Yields over two tons per hectare were achieved first achieved in 1980, peaked at 2.25 t/ha in 1982, and have fluctuated around a level slightly below two t/ha since that time. The recovery in area and increasing yield led to a recovery and expansion in output in the early 1980s. In 1990, a relatively large area planted and good yields led to a record output of 287,000t.

The land tenure system instituted in the first years of independence remains in place relatively unchanged. Africans own a significant proportion of the wheat-growing area, and are able to bequeath land to their sons. This has caused continued fragmentation of farms and subsequent decreases in the scale of some wheat farms. Inappropriate timing in

performing certain operations is a key factor affecting small-holder yields: farm contractors give preference to large-scale farms for custom operations, and labor bottlenecks present problems for small-holders who choose not to subcontract work to machinery operators.<sup>11</sup> These constraints diminish the profitability of small-holder wheat farming relative to maize. Consequently, much of the decline in area was the result of fragmentation of farms within the traditional wheat producing zones of Nakuru, Laikipia and Uasin Gishu and the resulting switch from wheat to maize on these farms. Only the expansion of wheat area in Masailand prevented national area from declining more dramatically in the late 1970s.

In the 1980s, increasing population pressure induced cultivation of low-potential lands, some of which were planted to wheat. This caused an upturn in national area planted to wheat during this decade.

Changes in the marketing system began immediately when President Moi took over power in 1978. Moi relaxed the membership requirements of KFA in order to enable many small scale farmers to join. Programs designed to benefit large-scale farmers, such as income guarantees (Guaranteed Minimum Return), were criticized and elimination was recommended. Over the following decade, the approach to agriculture changed into a growth-oriented strategy, with public investment in developing rural market centers and towns, budget reconciliation through structural adjustment, movement away from import-substitution strategies, improving conditions for the informal sector, greater reliance on decentralized price-setting mechanisms such as markets.<sup>12</sup>

These adjustments have had seemingly little influence on the structure of the wheat sector. The marketing of inputs and outputs continues to be controlled by a small number of firms. For example, by 1978 the KFA had become a vertically integrated conglomerate,

whose subsidiaries included Agricultural Machinery Ltd, Auctioneers Ltd, Kenya Seed Company, Royal Insurance Company of East Africa and Crop Protection Chemicals Ltd. The milling industry is still dominated by a few, large-scale, private companies. Unga Ltd utilizes 60 percent and the three largest millers purchase more than 90 percent of domestically-marketed, wheat production.

Nor have the adjustments made relevant price-signals available to small-scale farmers. Wheat marketing in Kenya today is characterized by a wide range of government intervention. The two outstanding ones are the setting of the price by the Ministry of Agriculture under the Agricultural Act (CAP 318) and the participation in the actual buying of wheat from farmers by the NCPB. Wheat imports in the form of food aid are increasingly used as a policy for solving balance-of-payments problems and for satisfying domestic, wheat demand. For example, in 1986 the government received 68,615 tones of wheat from the U.S.A under PL 480; this is nearly one-third of the quantity produced domestically, and three times the level of purchased imports.

Input markets function as poorly. Most notably, import quotas and regulated prices reduced the quantity of fertilizer available throughout the country, and the nature of the marketing institutions and government pricing policy directed most of what was available to larger farmers.<sup>13</sup> Following calls for structural adjustment, the 1990's began with attempts to open borders to greater levels of inputs.<sup>14</sup> However, recent re-regulation of fertilizer imports has quashed hopes of greater utilization.

Since 1977 there have been drastic and fundamental changes in the organization of research and technology development in Kenya. The sudden collapse of the East African Community in 1977 led to the disintegration of a wide range of regional institutions which



hitherto were jointly administered by Kenya, Uganda and Tanzania. The Science and Technology (Amendment) act, 1979, gave the legal framework of the formation of the Kenya Agricultural Research Institute (KARI), among others, to replace the EAAFRO and EAVRO.

Kenyan, real, wheat, research expenditures more than doubled in 1978. This is possibly an artifact of deterioration of regional institutions, so that KARI had to pick up expenses for some of the continuing programs. Expenditures continued to climb until 1983, when they plummeted by 75 percent. They recovered slowly over the next four years to one-third their previous level, and then jumped by over 150 percent in 1987. Since that time they have fluctuated slightly below the 1987 level.<sup>15</sup>

Until the 1980s most of the wheat research programs at Njoro focused on technologies appropriate for large-scale wheat production in the high potential areas. However, the increase of smallholder wheat production and increasing area under wheat in marginal areas has shifted the research priorities in the research center. Today, in addition to traditional research mentioned above, wheat research examines minimum and zero tillage options aimed at providing appropriate agronomic practices for the environmentally fragile marginal areas. There are efforts to increase mechanical research to improve the efficiency of small scale wheat production. The extension and demonstration components have been expanded to publicize small-scale, wheat-growing methods to the relatively new, small-scale, wheat farmers.

### III. Policy Implications

#### Wheat Self-Sufficiency

While self-sufficiency in wheat remains a stated goal of the Moi government, this goal is impractical. The recent history of population growth and increasing consumer demand suggests that demand will double to 840,000t per year in the absence of any relative price movements. With current yields, self-sufficiency will be accomplished only if wheat is planted on 400,000 to 500,000ha. The government does believe that area can be expanded to 500,000ha, primarily in the Narok district. However, expanding wheat area in the Narok district may entail environmental degradation, loss of tourism or reduced livestock production. Moreover, the history of wheat area in Kenya indicates that expansion has occurred only when the government has provided significant subsidies. In the current situation of restricted budgets and structural adjustment, provision of subsidies does not seem to be a feasible policy.

Another way of achieving self-sufficiency is through intensification leading to higher yields. However, with no area expansion, yields would have to double in the next decade to meet projected consumption demand. The historical record on the growth of yields in Kenya shows that peak yields doubled between 1921 and 1950, and have come close to but not quite doubled since 1950. It seems unlikely that Kenya will be able to meet consumption demand purely by yield increases.

Nor will realistic combinations of area and yield increases achieve production of 840,000t by the end of the century. For example, it would take a doubling of area from the 1990 level to 280,000 ha and an increase in average yields by approximately 50 percent to 3 t/ha to generate 840,000t of wheat. The rates of growth far surpass historical precedent,

and there is no indication (such as a miracle variety) to believe that they will be achieved in the next decade.

Finally, the objective of self sufficiency may not be desirable on economic grounds. The internal producer price of wheat in Kenya is approximately 125 percent higher than the world price.<sup>16</sup> The domestic, wheat-maize price ratio is twice the world-price ratio. While some of this price differential may be justified on the basis of transportation costs or positive externalities in supporting local farm income, it is clear that self-sufficiency in the near future will come only at a large cost. With in-kind food-aid in the form of wheat available to Kenya, it seems unlikely that self-sufficiency is a cost-effective goal, at least for the near term.

#### Reasonable Yield Targets

More reasonable goals can be stated in terms of yields or multi-factor productivity.<sup>17</sup> For example, achieving increases in average yields of 4 percent per year would lead to a doubling of output in two decades with no increase in land area, substantially faster than the historical record. Achieving such growth may require a combination of further improvements in varieties available, agronomic and mechanical recommendations, and greater use of purchased inputs such as fertilizer. A target growth rate of 2-3 percent per year for multi-factor productivity would have to be met entirely through technical progress, but could assist in increasing output substantially faster than the historical rate if input use increases.

### Fertilizer Policy

Examination of patterns of output growth during the green revolution periods in Asia indicate that output grew at first primarily because of adoption of high-yielding varieties. Once adoption levels were high, farmers then began increasing the use of chemical fertilizers and building up soil nutrient levels. During this second period, output growth was faster than in the first period. This suggests that wheat output growth and levels will depend on fertilizer availability.

Historically, Kenya has restricted fertilizer imports, citing lack of foreign exchange as a major constraint. As part of structural adjustment, these import restrictions were relaxed as of January 1, 1990. A survey of wheat farmers in 1990 indicated that farmers in high-potential areas applied approximately the recommended doses of nitrogen and phosphorus. Average fertilizer use is much lower in the low-potential areas, primarily because less than one-half of the small farmers use chemical fertilizer, and those that do use fertilizer apply lower than recommended doses.<sup>18</sup> It is unclear if the observed levels of fertilizer use were above historical levels because of the policy change in 1990, although aggregate consumption in 1990 did not increase over the previous year.<sup>19</sup>

In 1992, fertilizer policy once again became restrictive. Inadequate fertilizer supplies cause yields to grow more slowly than they otherwise would, and increases the difficulty of the problem facing breeders, agronomists, and other scientists attempting to increase productivity. Reasonable yield or multi-factor productivity growth targets are unlikely to be reached without continuing or expanded use of chemical fertilizers.

### Small-Holders or Commercial Farms?

KARI has redirected at least some of its wheat research efforts to address those problems peculiar to small-holders. To the extent that small-holders are a legitimate clientele group for KARI, this redirection is appropriate. However, small-holders account for approximately 15 percent of wheat area, and the comparative advantage of maize over wheat on small farms suggests that this proportion will not grow dramatically. Thus, in order to achieve average yield increases of 4 percent per year, or comparable goals, KARI will have to keep its emphasis on developing new techniques for use on the larger, commercial farms. For example, if yields on large farms did not increase, then small-holder yields would have to increase by more than 25 percent per year in order to achieve the 4 percent aggregate yield growth target. In contrast, if small-holder yields are stagnant, then large-farm, yield increases of 4.7 percent would achieve the aggregate target. The research policy implication is to continue to focus on technical improvement for large farms, with adaptive research for transmitting these improvements to small-holders and some work on problems specific to small-holders.

### Environmental Concerns

Environmental concerns are nowhere more evident than in Narok district, where game park and Masai grazing lands have been converted to wheat production. Large-scale commercial farms have expanded onto low-potential lands that tend to be more fragile, increasing the risk of soil degradation or other resource problems.

Fortunately, the tradeoff between household food security and environmental sustainability is less pronounced in Kenyan wheat than in other parts of Africa. With only

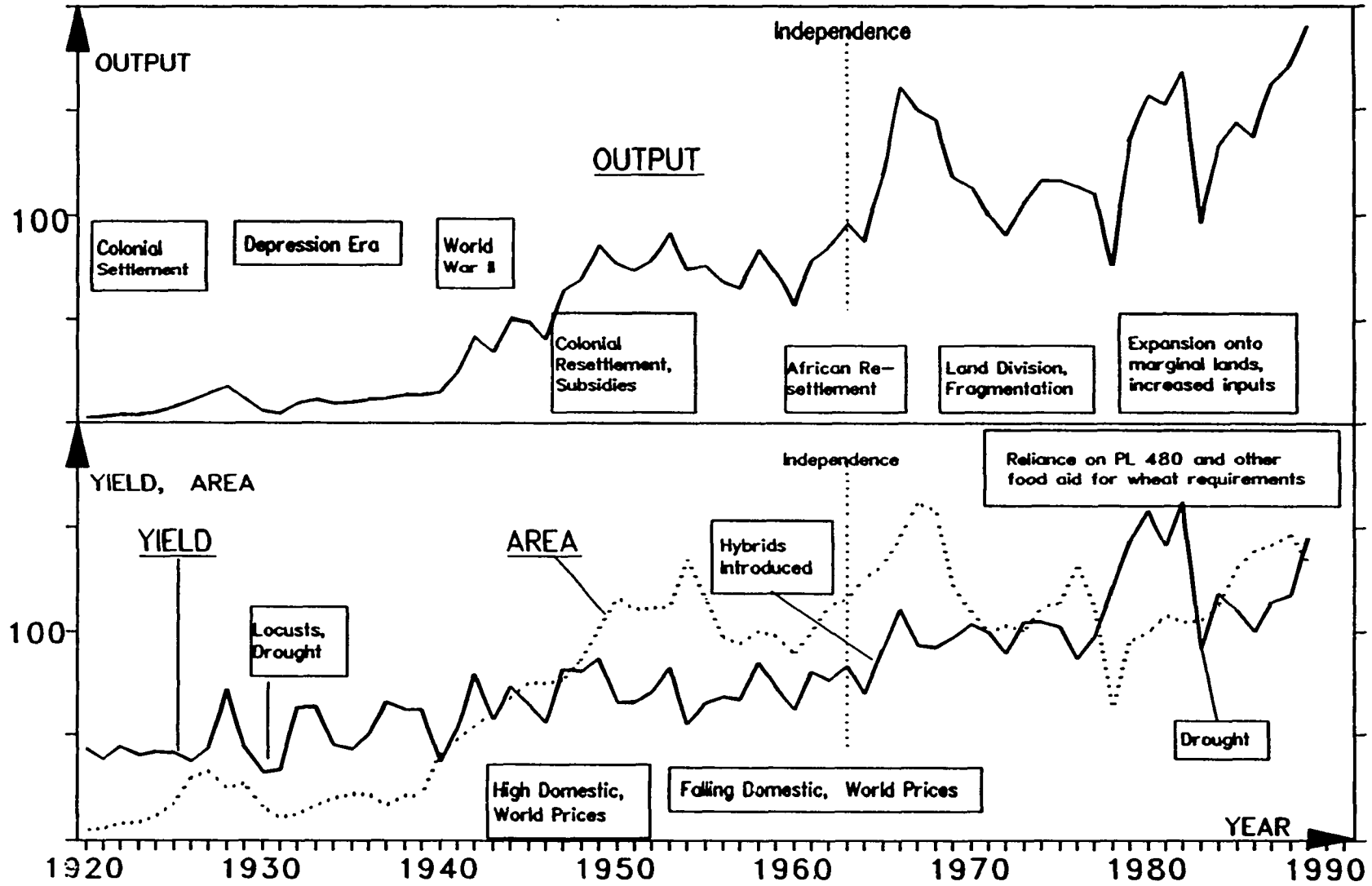
15 percent of wheat area cultivated by smallholders, and some of these cultivating the less-fragile, high-potential land, production techniques that place greater emphasis on resource conservation can be employed on the vast majority of wheat farms without hurting the poor, land-scarce, family. Large-scale farms may have access to the funds necessary for significant investments in resource-conservation measures. Commercial farmers may choose to make such an investment if it will enhance the productive capacity of the land. There is scope for investments which will lower increase ?? capacity at the same time as sustaining the agricultural resource base.

#### IV. CONCLUSIONS

The history of Kenyan wheat is dominated by government subsidies. For those few periods in which subsidization declined, such as the late 1960's, area and production declined significantly. Structural adjustment programs and the current budget situation will make it difficult to keep subsidies at historical levels.

In the absence of increasing subsidies, wheat self-sufficiency in the next ten years is not a realistic goal for Kenya. Moreover, it is unclear if Kenya has the capacity to compete effectively on the world market, particularly if developing countries are subsidizing exports or providing in-kind aid to Kenya. A realistic goal may be a four-percent annual growth rate for wheat yields, accomplished by increases in the use of non-land inputs, management skills, and technical progress.

Figure 1. Kenyan wheat output, yield and area, 1921 to 1990.



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**APPENDIX: DATA SOURCES**

Data on wheat output, area, yield and research expenditure for the period 1921 to 1982 was obtained from Makau (1984), who quotes the following sources:

**(a) Wheat Production and Area Planted**

Yearly wheat production data and area planted with wheat was obtained from the article by Pinto and Hurd (Seventy years with wheat in Kenya, *East African Agricultural and Forestry Journal*, XXXVI (1970):special issue), Annual Reports of the former Kenya Wheat Board and the current records of the National Cereals and Produce Board. Gaps for the war years 1939 and 1940 were filled with estimates from the Kenya Statistical Abstracts on production and records of correspondences in the Kenya National Archives on yields per acre.

**(b) Research Expenditures**

Research expenditures were determined from the following main sources and the best likely figures chosen:

(i) Kenya Department of Agriculture Annual Reports: 1921 to 1937. The annual reports stopped reporting on expenditures from 1938 onward.

(ii) Colony and Protectorate of Kenya Estimates of Revenue and Expenditure: 1926 to 1954. From 1955 onwards expenditures for Plant Breeding Services and hence wheat research expenditures were not recorded separately in the estimates.



(iii) Development and Reconstruction Authority Annual Reports: 1945 to 1951. This was an authority started in 1945 after the Second World War for reconstruction against the effects of the war. Apparently it disappeared around 1951 after it outlived its usefulness.

(iv) The Colony Development and Welfare Fund (CD&WF) Annual Reports and correspondences in files at the Kenya National Archives: 1954 -1956.

(v) National Plant Breeding Station, Njoro records of expenditure and AIEs (Authority to Incur Expenditures): 1957 - 1980. It is reported in archival records that there was a fire outbreak at the NPBS, Njoro in 1953/54 and therefore the records at the station before 1955 were destroyed.

(vi) Wheat Board of Kenya Annual Reports: 1963 - 1976.

(vii) End of Year Ledgers of the Ministry of Agriculture: 1974 to 1982. It is unfortunate that these ledgers are destroyed after a few years: they contain accurate information on the actual expenditures on every research station under the Ministry. It is not possible to get such accurate information from stations themselves because they control only part of their budget, the rest of the budget salaries and allowances being controlled at the Ministry Headquarters. Such information is easily lost after a few years when the Ledgers are destroyed.

(viii) DANIDA, CIDA, NPBS Njoro records and the 1976 UNDP Compendium on Development Assistance to Kenya.

(ix) Kenya Government Appropriation Accounts and Audit Reports.

The data were extended from 1982 to 1990 from recosts of the National Plant Breeding Center, Njoro.

## ENDNOTES

1. Ph.D. Candidate and Associate Professor, respectively. Department of Agricultural Economics, Michigan State University, East Lansing, MI 48824.
2. See Appendix for a description of data sources.
3. This description is from Makau (B.F. Makau, *Measurement of Economic Returns to Research and Development: The Case of Wheat Research in Kenya*. M.A. Thesis, Department of Economics, University of Nairobi, 1984). Makanda (D.W. Makanda, *Wheat Policy in Kenya*. Ph.D. Dissertation, Department of Agricultural Economics, Michigan State University) gives 1907 as the date at which Delamere hired a breeder.
4. The center developed into the current National Plant Breeding Station.
5. Makau, op cit.
6. Huxley, 1957. "No Easy Way: The Start of the Kenya Farmers Association," Nairobi.
7. Makau, op cit.
8. Nutrition-related disease was regarded by some as a problem with African overpopulation, who recommended population control as a solution (Makanda).
9. Due to disruptions from the war, figures for 1939 and 1940 are approximate.
10. Makau, op cit.
11. E.A. Hurd and M.W. Evans. "New Emphasis in Wheat Breeding in Kenya." *East African Agricultural and Forestry Journal*, 1969.
12. Statements of these policies appear in the government publications: Food Policy Paper of 1981; Sessional Paper No 1 of 1986, Economic Management for Renewed Growth; and the 1989-93 Development Plan.
13. V. Mazzucato, *Non-Research Policy Effects on the Rate of Return to Maize Research in Kenya: 1955-88*. M.Sc. Thesis, Department of Agricultural Economics, Michigan State University, 1992.
14. 1989-1993 Development Plan.
15. Particularly during this time period, the reader should not attach too much importance to any particular expenditure figure. Global inflation during the early 1980's; changes in Kenyan, exchange-rate policy; changes in the availability and allocation of donor funds; and the changing nature of the Kenyan research

institutions all affect the expenditure values reported. What is clear from the data is that this was a period of fluctuation and change in wheat research. Anecdotal evidence of the effects of changes in the research institutions, reprioritization of research objectives across and within commodities, and reorientation toward different clientele groups suggest that changes disruption or replacement of some research activities.

16. Makanda, op cit.
17. Multi-factor productivity is measure of how much output is generated per amount of all measurable inputs. In contrast to a yield measure, in which land is the only input considered, a measure of multi-factor productivity will consider inputs such as land, labor, animal or mechanical power, fertilizer, etc.
18. R Hassan, W. Mwangi and D. Karanja, 1992. Wheat supply in Kenya: Production Technologies, Sources of Inefficiency and Potential for Productivity Growth. KARI/CIMMYT Project Report (Njoro, Kenya).
19. Price-Waterhouse, 1991. Fertilizer Pricing and Marketing Reform Program. Midterm Evaluation.