Homework Assignment 20: Due at the beginning of class 11/14/01

Figure 1: Maize typical of that widely cultivated in Kenya.

In Homework 15, you analyzed the population growth of the African nation of Kenya. In this homework assignment you will model and study the food production of Kenya. When you have finished this homework assignment you will have calculated the problems of food supply that the Kenyan government and people will face in the near future (assuming that trends in population growth and food production do not change radically).

Kenya's economy is heavily dependent on agriculture with 75% of Kenyans employed in farming[1]. Many analysts regard Kenya as one of the African nations whose food production has kept pace with its population, despite the fact that only about 15% of Kenya's land area is suitable for cultivation[2]. Of the crops grown for domestic food production, the most important crop is maize (see Figure 1[3]). Table 1 (below) gives the amount of maize harvested in Kenya from 1963 to 1995[4].

Year	Production (thousands of metric tons)	Year	Production (thousands of metric tons)	Year	Production (thousands of metric tons)
1963	220	1974	1200	1985	2350
1964	200	1975	1300	1986	2600
1965	300	1976	1600	1987	2150
1966	400	1977	1650	1988	2750
1967	500	1978	1600	1989	2600
1968	600	1979	1575	1990	2300
1969	700	1980	1850	1991	2300
1970	800	1981	2550	1992	2600
1971	900	1982	2450	1993	1700
1972	1000	1983	2200	1994	2975
1973	1100	1984	1500	1995	2650

Table 1: Maize production for Kenya, 1963-1995.

1. Plot a graph showing maize production versus time. Based on the appearance of the plot, what kind of function would do a reasonable job of representing the overall trend in the plot? (Note that after 1975, the data do not show a clear pattern. Don't try a to find a function that will go through every data point, just try to identify a function that will summarize the overall trend.) Find an equation for this function and an equation for the derivative of the function.

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[1] Source: Uwechue, R. (ed.) (1996) "Africa Today. Third Edition." Capetown, South Africa: Africa Books Limited.

[2] Source: CIA World Factbook, 2001.

[3] Image source: http://www.cgiar.org/

[4] Source: Karanja, D.D., Jayne, T.S. and Strasberg, P. (1998) "Maize productivity and impact of market liberalization in Kenya." Paper presented at the Conference for Raising Smallholder Productivity and Welfare. (November 24, 1998, Nairobi, Kenya.)

2. The population of Kenya is very well described by the equation:

$$P(T) = 1316498.846*(1.032077091)^T,$$

where T = years since 1900 is the independent variable, and P = population is the dependent variable. The per capita maize production is equal to the amount of maize produced divided by the number of people. Find an equation for the per capita maize production and calculate the derivative of the per capita maize production.

Hint: One of the things that you calculated on Homework 15 that may be of some use here was the derivative of $P(T)$:

$$P'(T) = 41566.233*(1.032077091)^T.$$

3. When was the per capita production of maize increasing and when was it decreasing? When was the per capita production of maize at a maximum in Kenya? You should show all details of your calculations and be careful to provide evidence to back up your conclusions.

4. Sketch a graph showing the per capita maize production of Kenya as a function of time. On your graph, mark in the intervals and points that you calculated in Question 3. Your graph should (at least) cover the time period from the year 1950 to the year 2050.

5. According to experts, by the year 2010 sixty percent of the 37 countries in sub-Saharan Africa will not have sufficient amounts of food to meet their peoples' nutritional requirements[5]. The minimum annual consumption of food necessary for survival is estimated to be 100 kg per person[6]. According to the equation for per capita food production that you have found, when will Kenya no longer produce sufficient amounts of maize to meet domestic needs?

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[5] Source: U.S. Department of Agriculture, Economic Research Service. "Global Food Security: Overview." Food Security Assessment GFA-12, December 2000.

[6] Source: U.S. Department of Agriculture, Center for Nutritional Policy and Consumption. (1997) "U.S. per capita food consumption." *Family Economics and Nutrition Review*, **10**(1): 38-41.