TECHNOLOGICAL FORECAST OF ALUMINIUM IN FOOD PRODUCTION· PRELIMINARY RESULT

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ABSTRACT

It is pathetic that a nation that was self-supporting in main food staples and making large shipment of the main cash crops to the world market is now unable to feed fifty percent of her population in just under a decade. Moreover, with the fast declining per capita arable land mass, it will be a sine qua non if a rigorous and wholistic approach is not pursued.

It is in the context of the need for a systems approach to the poblem of food production that this paper is written. The problem of aluminium utilization in food production is not just an ancillary one but a major subproblem of the macro-problem and thus should be given some attention in national planning. However, with the usual data problem coupled with the time factor this paper is a casual investigation into the prospects of aluminium in food production vis-a-vis other major engineering materials viz. steel and plastics. A simple cross-impact methodology is used.

INTRODUCTION

The "Green Revolution Programme" (the Federal Government Agricultural Policy), as regularly explained by government spokesmen, is intended to make Nigeria self-surpporting in main food staples in 1985 and from 1987 to enable shipment of the main cash crops again to the world market. While this is a laudable objective the erratic trade policy since the turn of the last decade even into the so-called "Green Revolution " era (see Table 1) is paradoxical. This erratic trade policy only has had a dramatic effect on price levels, sending confused price signals to producers (which the green revolution programme seeks to discourage) but also has increased the risk to traders who market domestic supplies.

The problem of sustained food production for the teeming population of this great country with fast declining per capita arable land mass has to be tackled wholistically, and systematically. Looking at the various constraints both internal and external our food production problem appears to a multi-objective, multi-level optimisation problem and will require careful and coordinated dynamic planning process and control to adequately deal with this alarming food shortage in Nigeria. In fact, real value of per capita food imports has more than tripled in the last two decades (Table 2, Fig. 1).

TABLE 1: SUMMARY OF RICE TRADE POLICY

Sources: 1. The World Bank: Accelerated Development in Sub-saharan African, 1981.
2. Federal Republic of Nigeria office Gazzette, Vol. 70, No. 1.

Prior to April 1974	:	66.6% tarriff
April 1974 – April 1975	:	20% tarriff
April 1975 – April 1978	:	10% tarriff
April 1978– June 1978	:	20% tarriff
June 1978 – October 1978	:	10% tarriff
October 1978 – April 1979	:	Imports in containers under 50 kilos banned.
April 1979	:	Imports in containers 50 kilos and above under restricted licence.
September 1979	:	Six-month ban imposed on all rice imports
January 1980	:	Import licence issued for 100,000 tons.
October 1980	:	Rice placed under general import licence – no quantitative restriction.
1st January 1983	:	Rice in containers of 50kgs. and above prohibited provided that Import licences shall be awarded only to Federal, state and local government agencies.

An aspect of this global decision problem is the sub-plan for engineering materials, notably Aluminium, steel and plastic, in food production and processing technology. Aluminium, in addition to finding application in most engineering endeavours, has, in the last two decade become an important engineering metal in food production, processing, transport and packaging. Today, Aluminium has become a major requirement in sprinkler irrigation, dairies packaging for beverages, as well as solarization of rural agricultural activities.

The present and future use of Aluminium in food production is a problem with many facets and an attempt to forecast the level of use will not just be a simple extrapolation from past consumption, notwithstanding the usual problem of data. However, there is the need to have an

TABLE 2

FOOD IMPORTATION IN NIGERIA

Source 1. Awoyemi, (Ref. 1)

2. IMF, (Ref. 7)

Year	Value Market Price ₦M	Deflator (1975=100)	Population	Real Value per capita (₦)
1962	46.986	39.2	54.80	2.19
1963	43.804	38.2	55.67	2.06
1964	41,240	38.5	56.80	1.89
1965	46.076	40.1	57.40	2.00
1966	51.568	44.0	58.80	1.99
1967*	42.560	42.3	60.00	1.68
1968*	28.392	42.1	61.20	1.10
1969*	41.732	46.4	62.80	1.43
1970	57.694	52.8	64.40	1.70
1971	87.910	61.3	66.00	2.17
1972	95.104	62.9	67.60	2.24
1973	126.260	66.5	69.60	2.73
1974	155.708	74.8	71.20	2.92
1975	277.863	100.0	73.20	3.80
1976	438.927	124.3	75.20	4.70
1977	702.013	148.3	77.20	6.13
1978	1,108.662	176.0	79.60	7.91
1979	1,105.901	195.6	81.60	6.98
1980	n.a	215.9	84.00	n.a

The Nigerian Civil War, values do not include the Eastern States.

insight to this to avoid planning blunders. It is to this end that the approach of a simple cross-impact analysis is adopted to gain this insight to the future position of Aluminium in the food industry. This could be invaluable to our agricultural planners.

2.1 ALUMINIUM IN FOOD PRODUCTION

Although aluminium has a rather short history (about one century old) it has however, compensated for its late start by the swiftness of its development and is second to steel among engineering metals in its worldwide use. It has found application in many areas including food production and processing largely because of its inherent physico-technical properties and the result of extensive research and development in the laboratories and industries. Some of the chief advantages in food production and processing are its lightness, resistance to corrosion, non-toxity and workability to an almost infinite range of finishes. The major areas of aluminium application in the food industry are: irrigation and gardening, packaging and dairy.

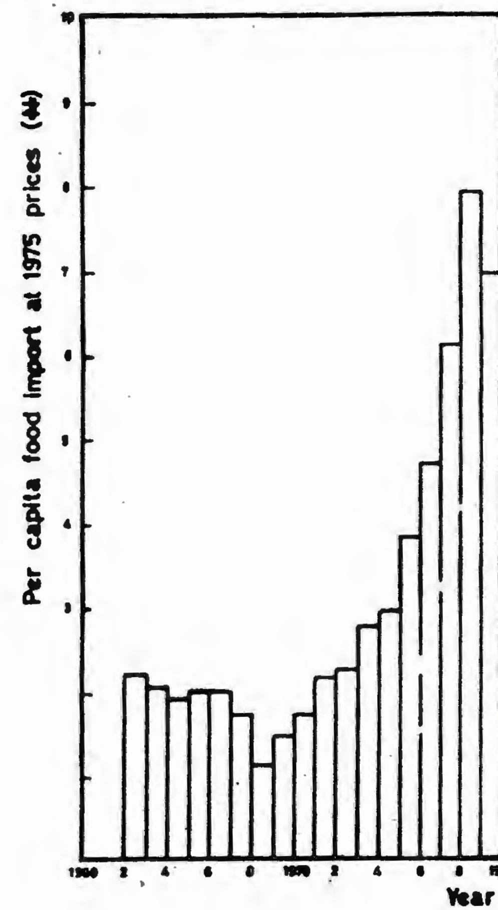

FIG.1: PER CAPITA FOOD IMPORTS AT 1975 PRICES.

2.1 IRRIGATION AND GARDENING

For any meaningful agricultural programme, irrigation is a vital, if not the cornerstone, aspect. Vegetation can be watered either by surface irrigation or by spinkler irrigation. However, the advantages of sprinkler irrigation as against surface are enormous. Some of these are: good water economy and management, good soil conservation, plant protection and reduction of unit cost of production. Sprinkler irrigation requires 30% to 50% of the water, depending on the type of soil and with efficiency going up to 90%, 2 or 3 times the area can be irrigated with available water using the right quantity at the right time. On the other hand, surface irrigation is characterized with leaching, and water logging.

In addition, fertilizers can be applied by sprinklers and also the washing action in sprinkling could wash off pests thus preventing diseases.

Aluminium, today constitutes a very large part of the sprinkler system. The irrigation systems are usually installed using pipelines that are easy to re-site, self-propelling or trailable over long distances. [Ref.1] . The aluminium pipe are made by hot extrusion while the rain applicators and accessories are cast items.

For gardening, aluminium is rarely used except as supports in viniculture. Also in sub-soil irrigation, especially for vegetation, plastic pipings are used except for cases, where in changing from one culture to the other the disinfection of the soil has to be done by high temperature heating instead of by chemicals, aluminium is used.

2.2 DAIRY INDUSTRY

In large scale dairy operations, aluminium is used for transport containers, coolers and pasteurizers. Experience over several decades have amply demonstrated that designs of aluminium manufacturing and storage equipment in dairies are not only more economical in use but also present numerous technological advantages in view of some of its properties mentioned earlier.

2.3 PACKAGING

Globally,, some 75% of aluminium packaging is used by the food industry. Demand by this sector is therefore of paramount importance in dealing with development trends. Analyses on international scale reveals a marked relationship between gross domestic produce (GDP) and modern aluminium packaging.

The main packaging areas are cans, glass tops, closures, packaging foils, hard-foil trays, collapsible tube, and low thin-walled sterilizable containers. Aluminium cans are made by cold extrusion or by deep drawing for shorter lengths. Glass tops are usually pressed from 0.15 to 0.25mm strips. Bottle closures are also deep drawn. Collapsible tubes are produced by cold extrusion and are used for packaging a multiplicity of items such as tomato pastes. In many countries some 10% of the total collapsible tubes produced are used in the food industry. Aluminium foils, which are produced by rolling has achieved substantial growth as a packaging item. In Nigeria, the utilization of foils is only in its infancy stage largely because 100% of foils used in this country are imported. However, one or two companies have plans for foil mills before the end of this decade.

2.4 SOLAR ENERGY

Aluminium is a principal component for solar collectors for running solar waterpumps and also in solar driers for agricultural products. There is presently current interest in the appropriation of the sun's energy for various application in our universities and research institutions. It is believed that with the current support by the government through research funding, the wide spread use of solar systems for rural agricultural activities will evolve.

3.0 FORECASTING ALUMINIUM DEMAND

The issue for forecasting methodology for Nigerian aluminium demand has been discussed at length by Onwugbolu [Ref. 9] from which it is clear that a hybrid of qualitative, casual or time series methods through dynamic modelling could be essential. However, before embarking on such an involving approach one needs to have a casual insight into the possible result and that is what this paper intends to achieve. To lay the foundation for this it will be necessary to discuss the current position of aluminium as it stands with other engineering materials used in food production as well as circumstances that will affect their relative demand in the future.

3.1 COMPETITION/SUBSTITUTION

Tinplate used to be traditional material of packaging in making cans, lids, bottle closures for the food industry. However, in current practice, aluminium is more and more displacing tinplate. In Nigeria, the use of tin-plate is high, but increasing use of aluminium is foreseen especially due to environmental legislations. Disposable aluminium packaging materials such as cans are valuable since they are easily recyclable thus reducing littering. In irrigation, the use of aluminium and plastics will continue to rise. Fig. 2 shows the substitution curve for aluminium and plastics from data obtained from a market survey. Both aluminium and plastic will possibly reach their saturation point before the turn of the century. In the dairy industry stainless steel is posing serious competition with aluminium especially in the last decade when aggressively reacting detergents came into use. For the future, stainless steel will win general acceptance for more sophisticated equipment where frequent cleaning is necessary e.g. milk thickeners, milk separators – but aluminium will keep up its position in the case of mass-produced mobile and stationary containers as well as storage tanks.

3.2 PRICE TRENDS

In general, the future position of aluminium may become precarious when the relative pricing of competing engineering materials decreases to the disfavour of aluminium. Fig. 3 shows general trend in the favour of aluminium for tin, steel and copper. However, the current chain of sporadic rises in the price of aluminium ingot will effect the long term growth in the use of the metal if it continues. Some possible reasons for this rises could be due to the depleting stocks with the global economic recovery and the capacity cut back due to increasing cost of energy. In Nigeria the establishment of a smelting capacity will definitely go a long way in stabilizing prices if long term price contracts are made for the alumina from Dabola in Republic of Guinea.

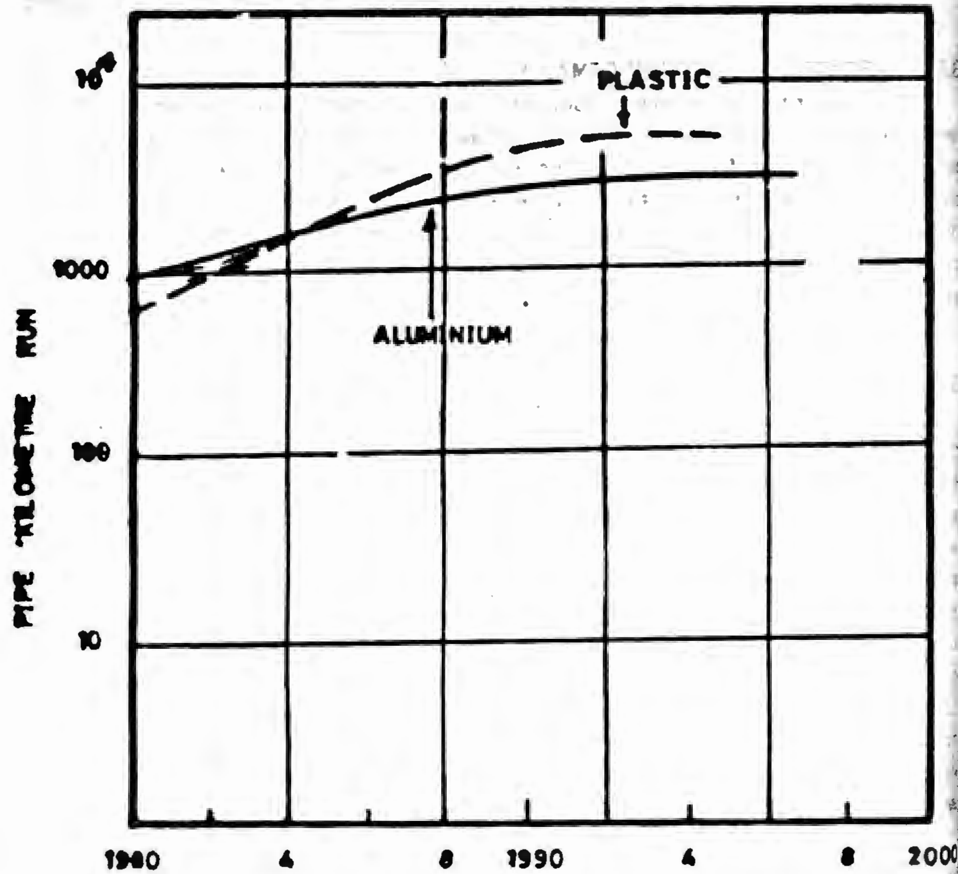

FIG. 2: PIPE DEMAND FOR SPRINKLER IRRIGATION (FOR DIAMETERS LESS THAN 100 mm)

3.3 LAND DENSITY

The fast declining arable land density (Fig. 4) will continue to justify the need for sprin irrigation specially in the North.

3.4 FORECASTING METHODOLOGY

The approach used to attempt to gain an insight on the future outlook of aluminium in fo production is a cross-impact methodology proposed by Kane [Ref. 8] which is really a primer consists of constructing the cross-impact matrix, made up of numbers on a scale of say −5 t obtained from interviewing experts in the relevant areas. [See Table 3]. The impact of one varia x_j on another variable x_i is given by

$$x_i\,(t+dt) = x_i(t)\,P_i(t)$$

where the exponent

$$P_i(t) = \frac{1+dt/\text{sum of negative impacts on } x_i/}{1+dt/\text{sum of positive impacts on } x_i/}$$

where i = 1, 2, ... 9
and dt = 0.1 and the sum of iteration is 10.

The results are shown graphically in Fig. 4(a) and 4(b) . It shows a bright outlook f aluminium and plastic. It is accentuated for the cause of aluminium with increasing irrigati activities due to the declining per capita land area and the governmental coersion towards loc manufacture. Apart from gaining insight to the future position of aluminium in food productio one will like to have the level of demand in quantitative terms. This is what a second part of th study will be dealing with. There are in any case, various in-house market surveys done by manu facturers and prospective ones. For example Table 6 shows three market surveys on the consum tion and forecast of aluminium for sprinkler irrigation. There are others in packaging and even f the dairy industry.

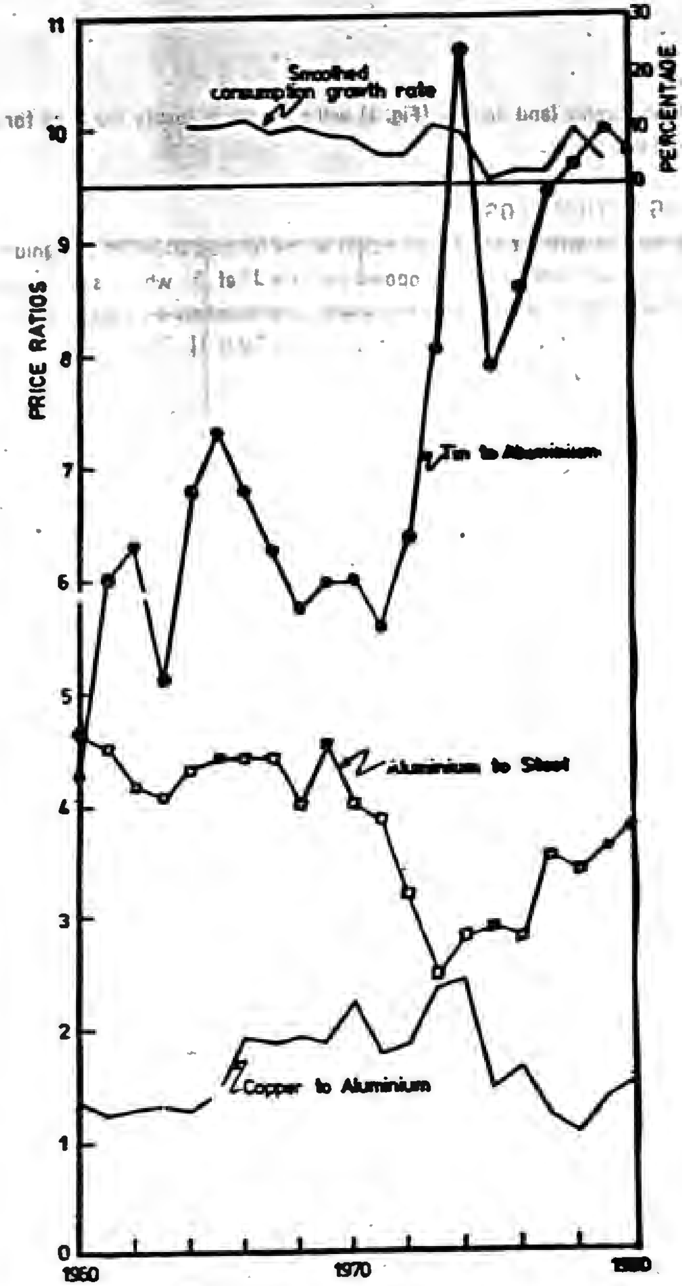

FIG.3: PRICE RATIOS OF SOME ENGINEERING METALS IN FOOD PRODUCTION.

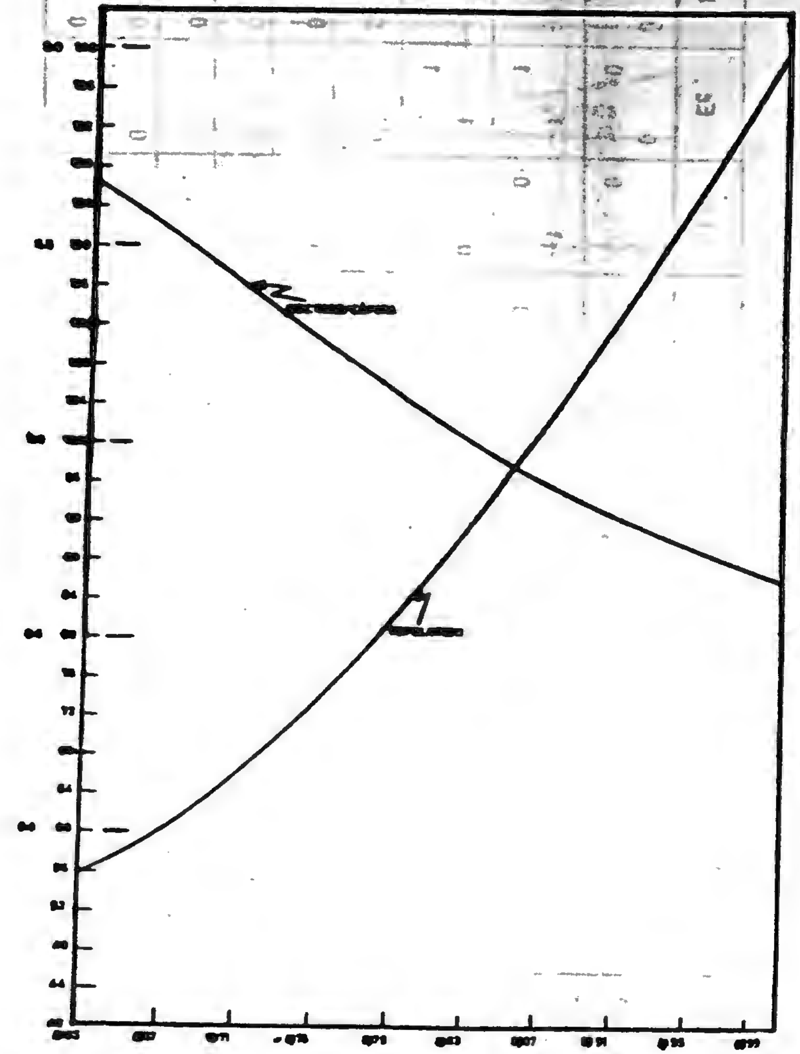

FIG.4: NIGERIAN POPULATION AND LAND DENSITY TO YEAR 2,000.

TABLE 3

THE CROSS IMPACT MATRIX

VARIABLES		A	S	P	Pa	Ir	So	La	Ec	Pr
Aluminium 0. 4, 0. 6	A	+1 1	–1 –1	–1 –1	+2 1	+2 +2	+2 0	0 0	0 0	0 –1
Steel (Tinplate) 0.6, 0.6	S	–1 –1	+1 +1	–1 –1	+1 0	+1 1	0 0	–1 0	–1 –1	–1 +1
Plastic 0. 5, 0.4	P	–1 –1	–1 –1	+1 +1	+1 +1	+1 +1	0 0	0 0	–1 –1	+1 +1
Packaging/Container	Pa	0	0	0	0	0	0	0	0	0
Irrigation	Ir	0	0	0	0	0	0	0	0	0
Solar Energy	So	0	0	0	0	0	0	0	0	0
Land Density	La	0	0	0	0	0	0	0	0	0
Economic Stabilization	Ec	0	0	0	0	0	0	0	0	0
Price Ratio	Pr	0	0	0	0	0	0	0	0	0

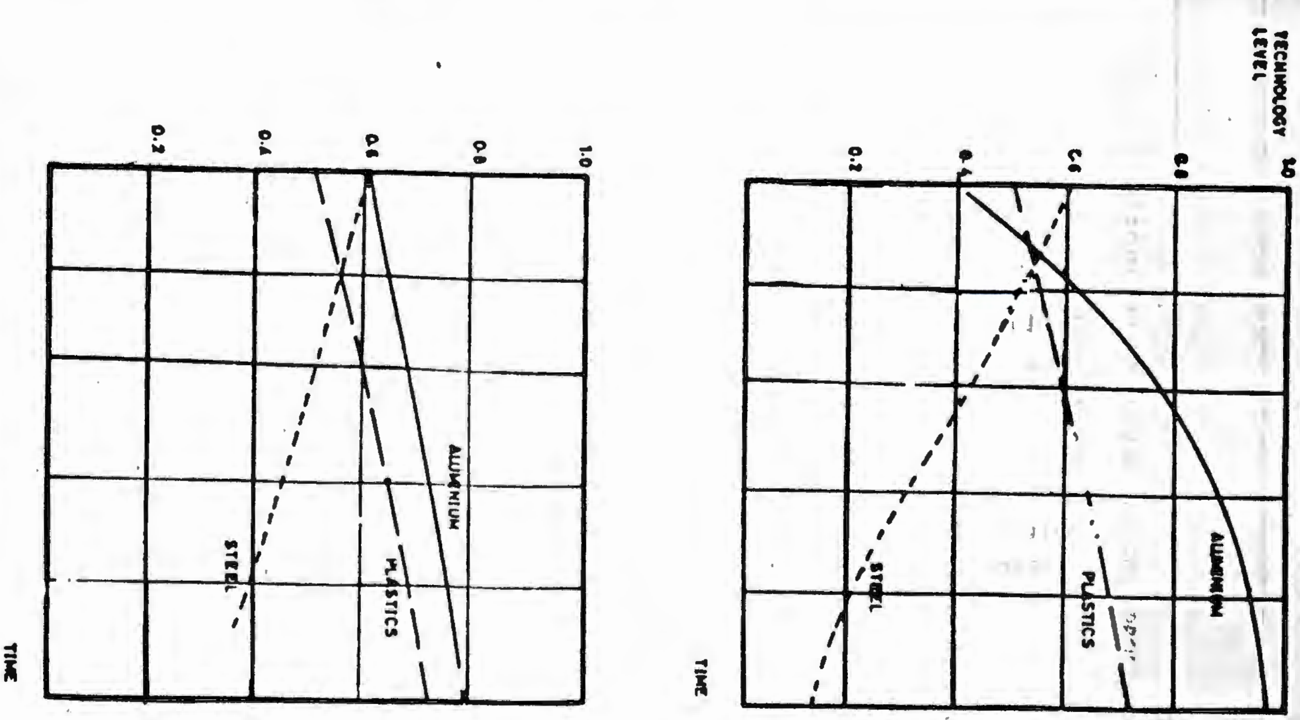

FIG.5 KSIM FORECAST OF ENGINEERING MATERIALS IN FOOD PRODUCTION.

TABLE 4

CONSUMPTION AND FORECAST OF ALUMINIUM FOR SPRINKLER IRRIGATION STUDY/SURVEY (MT)

	1 (Oct. 1981)	2 (Dec. 1980)	3 March 1981)	Average (MT)
1980	225	–	195	235
1981	–	–	306	–
1985	550	722	–	636
1990	850	1,524	–	1,187
2000	850	2,342	–	1,596

Assumptions

1. 75kg of Aluminium required for one hectare of irrigated land.
2. 7.5kg of Aluminium fittings for every 100kg of Aluminium Pipes.
3. 5% of total to represent annual replacement.

TABLE 5

CONSERVATIVE PROJECTION OF ALUMINIUM IN FOOD PRODUCTION AND PROCESSING IN NIGERIA

DESCRIPTION	PRESENT	2,000AD
1. IRRIGATION	250	1,600
2. CANS	650	5,000
3. COLLAPSIBLE TUBES & CLOSURES	2,000	3,200
4. DAIRY & COLD ROOMS	2,000	5,800
5. FOILS	1,500	2,500
6. HOLLOWARE	10,000	15,000
7. SOLAR ENERGY	–	1,000
TOTAL:	16,400	33,100

SUMMARY AND CONCLUSION

From the foregone discussion, it has been shown that one of the facets in the effort to making Nigeria self-sufficient in food staples and possible export of main cash crops in this decade is the planning of engineering materials, not only steel but also Aluminium. There is positive indication of growth in the future use of aluminium in food production and processing. In Irrigation, the consumption may well rise from the present level of 250mt to about 2,000mt by the turn of the century. The need for less dependence on natural rainfall combined with the availability of the fabrication capability of part of the irrigation system will tend to ensure this growth. Also with growing interest in solar energy application it is envisaged that about 1,000mt will be consumed in solar energy irrigation and storage.

The improvement in the living condition of Nigerians and the inherent techno-physical characteristics of Aluminium will help in maintaining its strong position in food packaging, cans and closures. The present consumption of about 3,000mt may well rise above 8,000mt by the year 2,000AD.

Aluminium consumption in holloware, especially kitchenware is quite substantial, and will be distinctly above 15,000mt by the end of next decade from the present 10,000mt.

In conclusion, the consumption of Aluminium in the food industry will be well over 30,000mt from the present 17,000mt by the year 2,000AD. This represents about 30% of the capacity of the planned Aluminium Smelter which has currently been shelved by the National Assembly. It is therefore recommended that the smelter plant project plans be revived especially since the semi-fabricating plant base, such as Aluminium rolling mills, Extrusion plant, etc, do already exist, Secondly, encouragement should be given to industrialists, (not the government) in setting up good aluminium foundries to meet the need of cast components in food production and processing technology which are hitherto imported.

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