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INDUSTRIAL PRODUCTION OF "GARI" IN NIGERIA 1/

by

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Summary

This paper gives a narrative of the experience of the Federal Institute of Industrial Research, Oshodi, Lagos, Nigeria and the involvement of other institutions in the technical development of an indigenous technology for the production of gari from cassava (manioc). The constraints imposed by inadequate infrastructure, socio-political and financial problems are highlighted. It is recommended that a technology transfer institution in a developing country should be actively supported by UNIDO to gain credibility and must have as a working base, an engineering design and fabrication facility.

INTRODUCTION

One of the major recommendations of the Economic Mission of the International Bank of Reconstruction and Development to the Nigerian Government in 1954 was that the industrialisation programme of the country should incorporate the early establishment of an applied technical and scientific research Institute which would build up staff, laboratories and experimental plant to conduct research into the industrial uses of a variety of products. The Institute was to explore the possibilities of new industries, operating pilot plants, improving local crafts and encouraging wider use of local materials. The Nigerian Government accepted this recommendation and established the Federal Institute of Industrial Research as it is now known with a core of expatriate staff whose expertises were largely oriented to technology and engineering. As a result of this situation, the early thrusts of the Institute for research projects were directed towards improving local crafts and developing indigenous technology.

The improvement of village scale processing of cassava roots into gari was one of the research projects embarked upon as a means of promoting rural industrialisation. Gari is a fermented, cooked and dried granular product which forms the staple food of more than 20 million indigenes of the Southern States of Nigeria. It is also widely known and eaten extensively along the coastal belt of West Africa. It has been estimated that up to about 70 per cent of the total cassava production in Nigeria amounting to 4 to 5 million tons per annum goes into gari manufacture. All of this is processed in the village by a local technology which is largely empirical in concept, efficient in performance but low in output and hygiene.

TRADITIONAL VILLAGE PROCESS

The traditional gari process consists of peeling the roots of cassava to remove the outer and inner corky layers. The peeled roots are then grated or rasped into a pulp and it is transferred into jute or hessian sacks or sack lined baskets to ferment over a period of 4 to 5 days. The pulp filled bags or baskets are usually wieghted down with stones in order to facilitate the drainage of the fermenting mash. When fermentation and dewatering are completed, the cassava pulp is screened on home made sieves to remove fibres and ungrated ends and stumps. The sievate is then fried on hot clay or iron pots with continuous stirring until gelatinization and drying are achieved. In some parts of the country, the frying of the cassava cake is done with palm oil to impart a cream to yellow colour to the finished product. Gari thus produced is a dried granular mass of particle size distribution ranging from 10 to 100-mesh standard sieve sizes and with a moisture content of between 10 and 15 per cent. It has a characteristic sour taste and a cold water swelling index of about 3.

Several attempts have been made in recent years to improve and modernise this traditional village process.

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The thrusts have been directed towards increasing production output capacity through mechanisation. The most successful innovation which has been adopted by traditional producers of gari is the mechanical grater, which may be powered and mobile. Usually, this machine is centrally deployed to serve a group of village producers who pay for their processing time. The other innovative stage of processing which has made incursion into the village scale operations is the frying or roasting of sieved and fermented cassava cake. Designs for this operation have been produced by FIIR, PRODA and FABRICO for throughput capacities of 150, 500 and 1500 kg. cassava cake per 8-hour day respectively. In all of these cases, the roasting devices lack temperature control systems and so gari frying has to rely on the intuitive judgment of the processors. In terms of its appropriateness to the village setting, the FIIR multiple frying range offers the best choice of the three because its production capacity is just about double that of the village production unit. Moreover, it is designed to use firewood as a source of heat energy, whilst there is no mechanical or motorised contrivance to require the services of technicians. The PRODA and FABRICO fryers on the other hand are of intermediate technology which may be powered and mobile, and would be more suitable for a small scale industry with capital investment on machinery and buildings of not less than ₦30,000.

../MODERN

MODERN INDUSTRIAL PROCESS

The development of the village technique of gari making into a modern industrial process was first conceived and investigated at the Federal Institute of Industrial Research, Oshodi. This was pre-empted by the realisation of the growing urban demand for gari which was estimated at about 500 tons per day in Lagos alone in 1962. Since then, the population of Lagos has almost trebled whilst the price of gari has more than doubled with indicative signals of shortfalls in supply.

Thus, fundamental studies were carried out in the Institute to understand the biochemical basis of the gari process and to develop an appropriate engineering design for industrial manufacture. Some of the significant results obtained from these studies were:-

(1) The cyanogenic glycosides and the leuco-compounds cyanidins and delphinidins are concentrated in the peels of cassava and therefore have to be removed in order to detoxify and avoid discoloration of the final product, gari.

(2) The peeled cassava must not be overpulverised to liberate a high amount of free starch. The free starch must of necessity be fermented out of the mash in order to make good quality gari.

(3) The fermentation of cassava takes place in two stages. The first involves

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Corynebacterium manihot, a bacterial organism which converts the free starch into lactic and other organic acids while the second involves a fungus, Geotricum candida, which produces the characteristic aroma of the fermented product. The fermentation system is essentially anaerobic and it is facilitated by the release of HCN which eliminates adventitious aerophilic micro-organism.

(4) The hydrolysis of the free starch during fermentation facilitates the dewatering of of the mash by mechanical pressure or by basket centrifuge.

(5) The traditional frying of cassava pulp essentially involves two antagonistic operations. The first is the gelatinisation step now referred to as garification in which there is low mass transfer but high heat transfer action. A critical relationship between the moisture content of cassava mash, the surface temperature of the gari-frying chamber and the contact time was thus established. The second operation involves a high mass but low heat transfer action when dehydration takes place.

The parameters have been taken into consideration in the design and fabrication of the Newell Dunford

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Mark III plant for an integrated process production of gari. It has been found that the most economical size for a mechanical gari plant is a 10 ton per day unit requiring a supply of 35-40 tons a day of cassava roots. The mechanical equipment involved is of particularly robust design and construction and is relatively simple to operate by unskilled labour working under suitable supervision. The plant process consists of the following steps:-

A. The cassava roots are delivered to the factory by lorry or trailer (loose or in sacks) and tipped into the storage area. The roots, hand trimmed if necessary, are manually fed into the peeler feed hoppers where the outer skins of the roots are removed. Water is added at this stage and the resulting trash and/or peelings are carried away out of the plant in a suitable trough to a settling pit or screening plant, and the solid residue used as animal feed.

B. The peeled roots are discharged on to inspection trays where further hand trimming may be carried out if necessary and, after inspection, fed on to a conveyor to the grater. After grating, the mash is fed into a mixer where seed liquor (4 day-old juice) is added as required. This also acts as a live surge hopper for the mash prior to the fermentation stage.

C. The mash is emptied into the fermentation vats which may be of plastic or glass fiber construction. The mash is then allowed to stand for approximately 3 days during which anaerobic fermentation takes place. At this stage, toxic gas (HCN) is given off and it is essential, therefore, that the fermentation area together with the rest of the gari plant should be well ventilated.

D. After fermentation has reached the desired point (decided by a combination of experience and acidity (pH) the fermented mash is put into nylon bags ready for pressing in a hydraulic press which squeezes out excess water. Alternatively, a basket centrifuge may be used.

E. The pressed or centrifuged cake is transferred to an elevator fitted with a gratertype inlet where lumps may be broken down by hand. The broken cake is then fed by a constant rate feeder to a sifter unit where any fibrous material is removed and bagged off separately.

F. The remainder is fed into a specially developed continuous garifrier of patented design where the starchy material is gelatinized. This part of the process is a critical one and must be operated strictly to specifications, and the solid residue used as animal feed.

G. The gelatinized cassava (gari) is then fed into a rotating cascading dryer where the moisture content of the product is reduced to a low level, thereby ensuring a long shelf life.

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H. The gari is then screened and milled to produce the particle size range required for the domestic consumption gari. The fines, (which are similar to fou-fou) are collected and bagged separately and provide a profitable by-product with a ready market.

COMMERCIAL PROSPECTS

As at today, it could be said that the process of gari making is available for commercial use at the village scale, intermediate and industrial technology levels. The traditional village process is still the dominant mode of making gari. The use of mechanical graters ranging from the manually operated to the motor driven types have almost completely displaced hand rasping of peeled cassava roots on home made punched tin sheets. FIIR has successfully tested the fermentation of cassava in vats and are currently using fiber glass silos in their pilot scale gari production. This could be adapted to village scale process to facilitate hygienic fermentation and less handling. The improved designs to traditional village frying of gari produced by FIIR and PRODA or FABRICO (respectively) have still not been adopted to a significant degree. Currently, only one of each of the designs is believed to be in operation in Nigeria. The potential for the transfer of the FIIR improved village scale technology to traditional producers could be high if given the right promotional thrust. It should bring about considerable increase in their [illegible] (about double) whilst at the same time improving [illegible] sanitation of the process and consumption quality [illegible] product.

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The PRODA and FABRICO plants will require a completely new organisational base different from traditional village production unit in order to take off. Small scale industrialists who would prefer this level of technology will however want to be assured of the technical reliability of the process. The lack of a temperature control system in the frying ovens may constitute a serious limitation in this context.

The 10 tons gari per 24-hour day industrial plant manufactured under FIIR license by Newell Dunford Engineering Limited offers a production dimension to meet current trend in the demand for gari in urban and industrial communities. It is therefore seen as the logical plant scale for an economy that is supported by modern agricultural infrastructure and developed marketing system. Its greatest limitation will be in the organisation of raw material supply to the factory. The first commercial plant set up in Bathurst, Banjul (former Gambia) was faced with this problem. Three other plants going up at Ibadan and Abeokuta in Nigeria and in Ghana respectively, are being linked with cassava plantations of not less than 1,600 hectares each. If these projects prove feasible commercially, the prospects will become very high that gari technology can be modernised and established in other relevant ecological zones outside West Africa.

../Assessment

ASSESSMENT OF THE TECHNOLOGY TRANSFER PROCESS

A critical appraisal of the historical events that occurred during the development and commercialisation of the industrial technology of gari production brings into perspective some features which have significantly affected the whole process of technology generation and transfer. This process has spanned a period of nearly 20 years and it is unique in that it has not only involved an urban-rural dimension but has also brought about an interplay of traditional and mechanical technology.

The early conception of the expatriate industrial engineers engaged to develop technologically the traditional gari production process was to increase throughput capacity by mechanising component unit operations. This resulted in the establishment of a technical process which though mechanically efficient, did not produce gari acceptable to traditional consumers. When, however, indigenous food technologists and scientists became involved in the appraisal of the technical process, substantial modifications of adopted conventional processing equipment were introduced as well as complete redesign of the software. A new technological process was thus established under a patent cover, but an integrated prototype design and fabrication of the hardware was required in order to test it for commercial feasibility.

Nigeria did not have a metal fabricating engineering industry at that time and under the prevailing finance budgetary constraints, outside assistance was sought

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through the United Nations, Government bilateral and direct institutional contact systems. The most advantageous offer in terms of time scale, investment risk and commercial realisation was received through the direct contact system. Thus an Engineering firm from an industrialised country was selected to produce the first prototype plant. Soon after successful trials with the prototype plant, this engineering firm decided on its own to scale up the plant to what it considered an economic size for commercial fabrication.

The effect of this action was to introduce a host of new constraints into the commercial application of the technology, the chief of which was the inescapable reality that the plant had become inappropriate to the traditional agricultural infrastructure for cassava cultivation. In more precise terms, the new plant capacity requiring 40 tonnes of cassava roots per day input would need to be supported by a large scale plantation of the order of 1,600 hectares. Fortunately for Nigeria, there was an on-going large influx of the population into the urban areas and Lagos, the capital city for example, was importing gari from the rural areas at an average daily rate of more than 500 tonnes. The commercial plant scale size proposed by our foreign engineering contractors thus became appropriate by implication of consumer demand. The investment capital requirement of

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the project was correspondingly escalated from the originally designed capacity of 10 tonnes per day input at US$50,000 to US$96,000 excluding plantation costs, although this was expected to be accompanied by an exponential increase in the rate of return on capital invested.

Not unexpectedly, there was a backlash from the conservative elements who saw the whole research programme as an attempt to rob village producers of their means of living. Studies were then mounted and financed by academic institutions to investigate the social effects of large scale industrial manufacture of gari on rural producers and organised attempts were made to discredit the technology as inappropriate. The effective counter to this was the fact that a pilot plant producing gari by the new technology demonstrated the practicality of the idea as well as the comparative advantages in the quality of new product over traditionally prepared gari. The 3 commercial projects that are being implemented have taken their investment decisions based on these considerations. One of them now in active production has retained the FIIR as a technical consultant for its production operations.

CONCLUSION AND RECOMMENDATION

The experience of the FIIR with developing and transferring technology in Nigeria as typified by the case study report on gari technology underscores the

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need to plan for an adequate infrastructure that can support a technology transfer process. This infrastructure should include the establishment of a multidisciplinary institution which will engage in techno-economic studies and services. Its staff should be largely drawn from indigenous or local experts with free access to interact with the international community of technologists and industrialists. Facilities for and capabilities in the design and fabrication of processing and control equipment are crucial to a realistic involvement in producing appropriate technology and therefore an organisation to be charged with responsibility for technology transfer and development must have these for a working base.

The operational activities of a technology transfer centre within the context of a developing economy would have to contend with conflicts and competition from multinational corporations, industrial machine peddlars and investment speculators. In order to survive the avalanche, international organisations such as the UNIDO should provide the bedrock support to build up the credibility of the institution to the national government for the purpose of adequate funding. Such funding should be extended to the commercialisation phase of the research results.

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