Individual Fired Brick Domestication in Nigeria

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Abstract. Individual fired brick domestication is not widely practiced; yet the fired brick has played and will continue to play an immense role in the global built environment. Its pivotal task of creating and sustaining architectural structures is ancient and has permeated through to contemporary times courtesy of clay's colossal vitality. Clay exploration and exploitation are perhaps most apparent in fired brick production, particularly in first-world countries with a diverse range of clayware such as bricks and tiles. This development has not been fully maximized in Nigeria as a result of the small number of refractory plants whose total production capacity is beneath the nation's building requirements. This scenario makes fired brick procurement costly and limits its accessibility; consequently, it promotes socio-built inequality among viable fired brick prospectors. In view of the aforementioned, this paper advocates individual fired brick domestication in Nigeria's rural and suburban settlements, providing concise practical details, from materials identification and mould fabrication to brick production. When fully harnessed, this is hoped to create jobs, alleviate the country's fired brick deficit, boost individual economic standing, communal economies and ultimately the national economy. Possibly it could serve as a template in similar settings around the world.

Keywords: *clays; fired bricks; mould; refractory/structural bricks; theory.*

1 Introduction

Domestication can simply be called man's adaptation, elevation or enslavement of a thing in a jurisdiction foreign to the one in which the thing was originally created or innovated [1]. Its primal trajectory is traceable to early man's adoption of gathering with apparent evidence in cultivation as opposed to wandering, which often promotes straying and unguided engagement [2]. In the case of fired brick, its ceramic domestication, unlike handcrafted pottery, is still alien to the people of Sub-Saharan Africa and particularly by individuals in Nigeria. An assertion that can be argued from the Yoruba perspective, where clays have hitherto been mined collaboratively and processed for pottery, which encapsulates building constructions, exemplified in slap houses locally referred to as *Ile Alabara* in the Yoruba language. According to the *Ifa* divination corpus, *Obatala*, the Yoruba arch divinity, pioneered domiciliation in clay slap houses, as captured in *Odi-Meji* as follows:

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Ako'le roboto a ni ki Oosa o gba
… … … …
Awon lo d'ifa fun Asamo
Won a bu fun Odimo
Won a bu fun Odimondimo

A small and circular house was constructed for Oosa
… … … …
Ifa divination was cast for Asamo
It was also cast for Odimo
So also was it cast for Odimondimo. [3]

The above verse tells how for Oosa Obatala, also known as Alamo, was made a small but befitting clay abode, collectively executed by his prodigies Asamo, Odimo and Odimondimo, who were masterfully skilled in building with clay [3]. This episode supposedly informed the humble beginning of mass involvement of builders in architectural structure, as articulated in the Yoruba axiom below:

…Igba eke
N'ifi owo ti ile
Igba Alamo
N'ifi owo ti ogiri…

… Two hundred brush woods
Clamped arms on a house
Two hundred Alamo
Clamped arms on the walls…

The above lines attest to the enormous amount of wood and professional personnel involved in Yoruba traditional architecture. The building masters helped in applying the compounded clay and wood used to strengthen and hold together the walls and roofs of slap houses [3,4]. It is however, interesting to note that locally 'slap house' *(Ile-Alabara)* and 'mud (clay) house' *(Ile-Alamo)* are often used interchangeably to appraise the intrinsic and extrinsic value of their appellations from the activity and material point of view. Unfortunately, these materials – unlike fired bricks, stones and metals – are perishable. Their ephemeral nature, caused by humidity and water saturation, is responsible for the premature collapse of the average Yoruba traditional buildings, typified by the remains of the walls and floors of Oyo Ile [4,5]. Although the above Yoruba model of compounding clay in constructing sun-dried walls of mud houses may not have exhaustively saturated Nigeria's regional divide, it is a pointer to the nation's hitherto non-emergent fired brick tradition [6]. Nonetheless, *Alamo* had precedents in the compounding, moulding and firing of clays [3].

Fired brick domestication is no doubt in the purview of industrial production in plants, with instances in refractory and structural bricks [7]. The term 'fired brick', however, indicates a conglomeration of all kinds of bricks that undergo heat pressure. It is a universal set that contains firebricks and a host of other subsets; in other words, fired brick is a generic term for all heated bricks, firebricks included. Its humble beginnings are traceable to the monumental architecture of ancient Egyptian civilization evidenced by the construction of huge *mastaba* tombs before 2700 BC from rectangular sunbaked mud bricks [8]. Further advancement of sun-dried mud brick brought to the fore brick firing in kilns, pioneered by modified bonfire in open pits, also called open air firing kiln, followed by the up draught kiln and later the down draught kiln innovations [9,10]. This development materialized the fired brick, among other things, contributing to the expansion of houses, palaces, temples and administrative buildings, instanced in Saqqara. Later, the transfer of fired brick technology became apparent in the Middle East, Far East, Europe, the rest of Africa and the Americas [8].

Although it is not clear when exactly domestication of fired bricks commenced in Nigeria, its emergence hinged on an unconscious and a conscious phase, the earliest being the unconscious phase, which is traceable to the efforts of Daniel Robert, a foremost British ceramic experimentalist. He, in 1904, pioneered advocacy for the introduction of thrown pottery using wheels in Ibadan, Nigeria. Though his attempt failed, it was later rejuvenated by Kenneth C. Murray, who took it from Ibadan to Umuahia and Lagos in 1928 and 1938. Their efforts were material to the establishment of Abuja Pottery Training Centre in 1950 by Michael Cardew [11]. These centers are believed to have locally used conjectural firing to produce refractory bricks, complemented by imported ones, for the building of kilns [9]. The latter phase was followed by the establishment of the Ikorodu ceramic industry in 1952, which marked the dawn of the conscious phase, during which large-scale fired brick domestication became imminent. This development was motivated by the country's bid to reduce her ceramic goods deficit of 3,000 tons per year, which was caused by importation from England, China, Germany, Japan and Czechoslovakia [4,7,12].

The proposed capacity of the Ikorodu ceramic industry of 500 tons per year was premised on Nigeria's immense reserve in fine-grained earthy mineral, known as clay [7]. Clay, a mineral with widespread global occurrence, is formed as a result of hydrothermal alteration of granitic rocks, particularly in warm tropical and subtropical regions of the earth [13]. Its variations are kaolin, feldspar, adobe, flint, shale, bentonite, bauxite, terracotta, etc. Chemically, clays are mainly composed of hydrous alumina silicate with fractional quantities of sodium, calcium, magnesium, potassium and iron to mention but a few. They are plastic when wet and become rock-like when pressurized by high temperatures [14]. Clay is the most employed mineral in the manufacturing industries in Nigeria, applied ornamentally and monumentally in refractory and structural ceramics, as exemplified in the Ikorodu ceramic industry with products such as red tiles and bricks [7].

Nigeria's share of the globe's lithospheric 'clay' pie became obvious with the establishment of more red brick plants after the Ikorodu ceramic industry. These plants were minorly and majorly owned by private and public corporate bodies. G. Cappa, an Italian building and civil engineering firm, pioneered the privately owned plants, commencing operation in fired clay bricks and other building components in the 1960s under the name Clay Industry Nigeria Limited [15,12]. Meanwhile, the Nigerian government through the establishment of the Nigerian Mining Corporation (NIMCO) under Decree No. 39 of 1972, initiated the first takeoff with seven (7) plants in 1977; later more than thirteen (13) others were built across the nation. Today, the story is not the same, as many of the government owned plants have failed and folded; those still in operation do so at a very low capacity [4,7]. Even government research initiatives, manned by the National Science and Technology Development Agency (NSTDA), the Federal Institute of Industrial Research, Oshodi (FIIRO), geology and chemistry departments of Universities, aimed at obviating possible challenges of the sector could not stop the inevitable from happening [7].

Noble as the latter initiatives in optimization of fired brick production were, they were anchored in theoretical criticism and censorship, jettisoning practical application. Their findings to a large extent ended up on the library shelves of formal institutions, which left the country with few operational ceramics plants and an apparent shortage in fired brick production. This shortage was further reflected in the well over two hundred and fifty thousand (250,000) housing units recently demanded by the Nigerian police and her armed forces, a fragment of the nation's built environment [7].

In view of the aforementioned issues, this paper advocates individual fired brick domestication, particularly in rural and suburban parts of Nigeria, so as to ameliorate the dearth of refractory and structural bricks through domestication of fired bricks individually and possibly independently. In bringing this assertion to the fore, certain fundamentals such as materials identification, mould fabrication and brick production, are discussed with concise manipulative theorization of their procedural algorithms below.

2 Material Identification

Identifying and sourcing necessary materials needed for bringing individual fired brick domestication into reality are paramount. As such, the materials can be classified as *facto* and *defacto*. Clay and water are classified under facto materials; this is so as a result of their being natural and undefiled, moreover they are fundamental to bringing the exercise to fruition. Man is to metaphorically assume the seat of the ‘mechanic’ whose job is to see to the smooth running of the fuel ‘water’ in the engine ‘clay’, making sure that the clay is well tempered with sufficient water. Meanwhile, wood (plywood, mansonite and planks), nails, glass sheets, glass cutter, perspex, plastic cutter, hammer, shovel, bucket, flat wooden bat, metal sheet, saw, sawdust, glue, hand plane, angle bar or L bar, kiln, among others, are classified as defacto materials, because they are all industrially refined products and are readily available or can be made available locally.

Studies on clay occurrence, reserves, geophysical mapping, thermo-physical/chemical composition, application, utility and economic evaluation reveal well over one hundred (100) major clay depots in Nigeria. Some which are: Obot Itu, Mbak Etoi, Ikot Ebom, Etinan, Nkari and Abak in Akwa Ibom State, Uruove-Ugheli, Isoko South, Ndokwa, Okpe and Sapele in Delta State, Ifon, Erusu, Akoko, Ode-Aye and Arimogija in Ondo State, Katsina Ala, Otukpo, Buruku and Makudi in Benue State, Lavun, Gbako, Agaie, Dangara and Kutigi in Niger State, Aguata, Ihiala, Ukpor and Njikoka in Anambra State, Asero, Bamajo, Onibode, Ile-Ise Awo and Ajebo in Ogun State, Kachia, Mararaba-Rido and Farin-kassa in Kaduna State and Adesekun, Omi-Adio and Alakia in Oyo State [13,16-20]. These findings no doubt affirm the varietal suitability of the country’s clays [20-26].

3 Mould Fabrication

Moulds are immemorially fashioned in wood or metal. To make a metal mould, the involvement of a professional welder is inevitable. This is so because the welding machine and soldering iron needed in fusing the measured edges of the mould sheets together are mostly available in a mechanical workshop. For the wood mould, one may or may not need to involve a carpenter to get it done, in as much as the required materials are readily available. For realizing any of these options, some of the *defacto* materials mentioned earlier are manipulated to form the mould. The dimension of the mould is also considered so as to achieve the desired shape and size. Straight ($4^{1}/_{2}$ x 9 x $4^{1}/_{2}$cm), split ($1^{1}/_{2}$ x 9 x $4^{1}/_{2}$cm), soap ($2^{1}/_{2}$ x 9 x $2^{1}/_{2}$cm), wedge (2 x 9 x $4^{1}/_{2}$ x 3cm), arch (1 x 9 x $4^{1}/_{2}$ x $2^{1}/_{2}$cm), end skew ($6^{3}/_{4}$ x 9 x $2^{1}/_{2}$ x $4^{1}/_{2}$cm), side skew ($4^{1}/_{2}$ x $2^{1}/_{2}$ x 9 x $2^{1}/_{4}$cm), edge skew ($1^{1}/_{2}$ x 9 x $4^{1}/_{2}$ x $2^{1}/_{2}$ cm) and feather edge ($2^{1}/_{2}$ x $4^{1}/_{2}$ x 9 x $^{1}/_{8}$cm) are details of some of the standard moulds, their names and dimensions [9]. Although, these brick standard mould dimensions are common knowledge, they are sometimes altered to suit individual purposes.

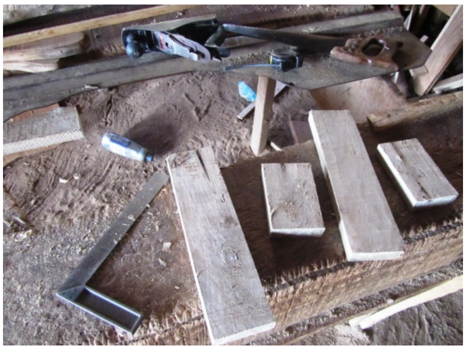

Figure 1 H-plane, L-bar, saw and sized planks. Photograph by Raji, 2015.

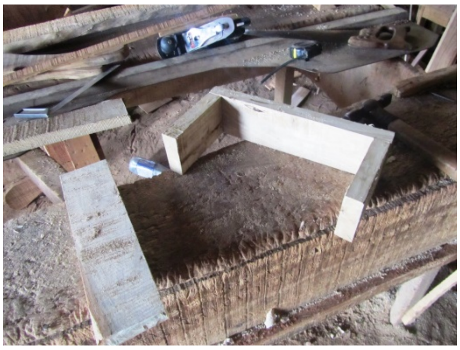

Figure 2 Coupling cut planks. Photograph by Raji, 2015.

Figure 3 Rectangular wood mould. Photograph by Raji, 2015.

Adopted in this exercise was a straight mould of wood cum glass, in view of its affordability, accessibility and possible fabrication even in the remotest parts of the country by novice or layman. To get started either plywood, masonite or planks may be used. Then cut any of the wooden options to a regular mould dimension or as you may like it. In this case, both sides of the employed plank were smoothened to the desired thickness and cut to size with a hand plane and saw respectively (Figure 1). The pieces were then coupled together, using a hammer to fasten nails into each edge of the frame, forming a rectangular piece (Figures 2-3).

The form or mould as thereafter attached with two handles, which allows for easy movement and suspension of the mould during brick casting. Silver plated metal handles or improvised wooden handles can be screwed or nailed onto the mould. At this point, the mold was ready for use. However, the incompatibility friction between the clay and the mould surface (often resolved through the application of grease, used/black oil or water at each brick casting interval) needed to be resolved. To obviate this, the mould's inner walls were laced with an adhesive for onward attachment of a tailor-measured glass one after the other cut from louver glass and was then allowed to stabilize before being put to use (Figures 4-6). Any other sheet glass or perspex may also be used.

Figure 4 Lacing the mould wall with adhesive. Measuring glass for cutting. Attachment of glass on mould wall. Photograph by Oyewo, 2015.

Figure 5 Measuring glass for cutting. Photograph by Oyewo, 2015.

Figure 6 Attachment of glass on. Photograph by Oyewo, 2015.

4 Brick Production

Brick production in this case was segmented into two main processes: (1) clay mining cum preparation and (2) brick casting, drying cum firing. Although clay is abundantly available in the country, it needs to be mined. In a nutshell, mining simply means to collect clay and as such identifying the clay site or sites in one's locality. Whether it is kaolinite, adobe, laterite/common red clay or fire clay, is of the utmost concern. Having done this, mining can commence by chopping or digging out the clay from the site or deport, which maybe in a hill, river bank, stream or pit, with shovel, hoe, cutlass or any sharp object. The yield is then bagged into a container, bucket or sack, which is in the case of a humble beginner or a fresh starter, but for an ambitious starter a truck load will not be a bad idea.

Figure 7 Marching aggregated clays. Photograph by Akinde, 2001.

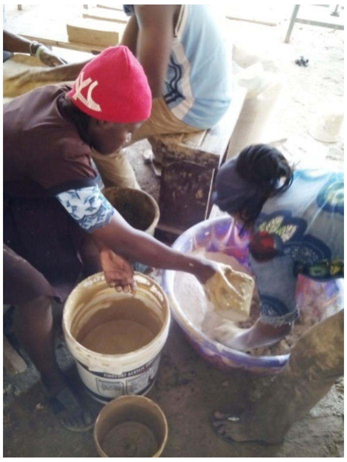

Figure 8 Pouring diluted adobe on powdered kaolin sawdust. Photograph by Oyewo, 2015.

Figure 9 Kneaded clay ball. Photograph by Raji, 2015.

The mined clay is then subjected to preparation. Clay preparation is an age-old practice and its techniques have evolved overtime: marching, kneading, wedging, ball milling and pug milling are some of its evolutions. The goal of preparing the mined clay is to make it ready for use. For a beginner, marching, kneading and wedging are the most advisable techniques, depending on which is most convenient for you. Marching, just as the name suggests, is a vigorous, rhythmic and continuous stepping of feet on the clay body to achieve a harmonious and homogenous mass (Figure, 7). Kneading and wedging are similar to each other, in the sense that they both involve the usage of hands; their difference, however, is in methodology, as the one is done by cutting and slapping while the other is done by pressing, knuckling and beating. In essence, wedging is the cutting of a block of clay and banging one down on the other until a consistent, bubble free mass is achieved. Kneading on the other hand is pressing either by forward or inward thrust of the bull's head approach or spiral approach, which allows for the treatment of a somewhat larger block clay [27].

For this exercise, the adopted technique used was kneading. The recipes to be kneaded were *Titibi* kaolin, *Igbon* adobe clay and *Atenda* sawdust aggregated in a ratio of 3:2:1, all in powder state. Thereafter, the adobe clay was diluted with water in a bucket to create a slurry of thick smooth creamy consistency. Also the kaolin and sawdust were mixed in a bucket. The slurry was then gradually poured onto the kaolin cum sawdust, resulting in a coagulation that was immediately kneaded until a ball was achieved (Figures 8-9). As many balls as possible maybe kneaded (Figure10) before proceeding to casting them into bricks, or one may also cast immediately after a ball or two has been kneaded; the choice is open.

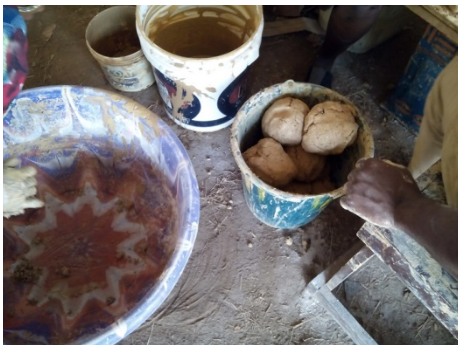

Figure 10 Bucket filled with kneaded clay balls. Photograph by Raji, 2015.

Casting is the next process. It is at this point that the fabricated mould is put to work. The mould is first placed on a plane board. The kneaded clay balls are then slammed into the mould one after the other, and rammed or pressed with a wooden shaft to expel air spaces (Figures 11-12). Its excess is then scraped off with a knife or any sharp object. The edges of the mould are further finished to great finesse using a plastic scraper (Figure 13). The content of the mould is then offloaded gently by pressing out the cast onto another flat board or bat that can contain four or more casts. Immediately after the required number of casts' is reached, they are moved for drying onto an airy open field, where they are gradually and properly dried. The bats allow for easy daily drying maneuvering of the bricks between sunrise and sunset. It takes one to five weeks to dehydrate the bricks, depending on the season. The numbers of casted bricks in a day is subject to the capacity of the individual involved, availability of bats and the volume of kneaded clay balls.

Figure 11 Slammed clay balls in the mould. Photograph by Raji, 2015.

Figure 12 Ramming with wooden shaft. Photograph by Raji, 2015.

Firing the completely dehydrated bricks expels all their chemically combined water contents, otherwise known as microscopic water. To do this, a kiln is required. It is advisable to fire in any of the variations of the open firing technologies, some of which are open-field firing, open-pit firing and cylindrical-chamber firing; none of these require a permanent structure. There is a thin line between open-field firing and open-pit firing, in that both require the use of a field. While the former is done on the field's surface, the latter digs up the field to a depth of between 14 to 20 inches and an area of several square feet. Dried grasses, twigs, reeds, dried dung and log of woods are some of the possible fuels. Their adoption depends on which fuel is readily available in a locality at a particular point in time. To commence firing, fuels are stacked under, on and around the stalked bricks; the fuel is then ignited. Firing is initially slow but later picks up under persistent fueling. This continues until the embers are glowing red hot around the bricks. The fire is then put out, allowed to die down. The fired bricks are left to cool off before offloading them.

Although heat loss is inherent in open firing, its heat capacity is estimated at between 700 and 900 °C [9,10].

Figure 13 Mould dressing with knife. Photograph by Raji, 2015.

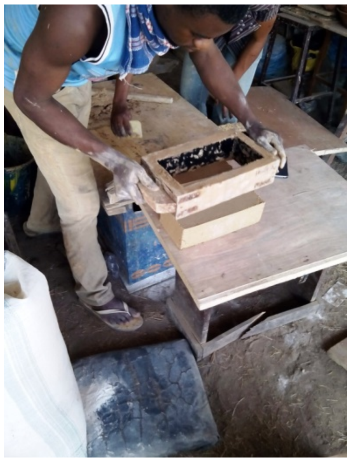

Figure 14 Brick casting. Photograph by Raji, 2015.

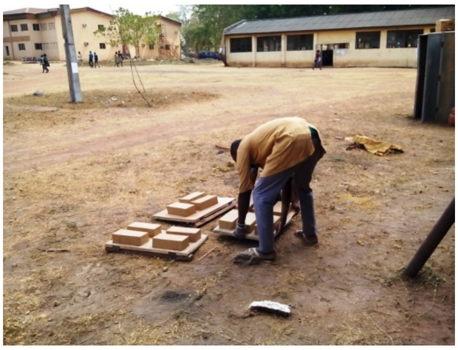

Figure 15 Drying of bricks in the open air. Photograph by Raji, 2015.

Although constructing a kiln was not part of this research, for the record, the kiln adopted in this exercise was a cylindrical chamber, constructed with marched laterite or red clay by slapping or banging the tempered clay until the desired design is achieved. This kiln had four fireboxes; its chamber was stalked with bricks alongside other wares as a result of the limited bricks that are available for firing. The rim of the kiln was then covered with used ceramic roofing sheets; any other high temperature resisting material is appropriate too. Thereafter, the edge of the kiln housing the cover was married with tempered clay body by wedging the two surfaces together blocking all identified spaces. The fuels employed were a combination of bamboo and wood, burning slowly for between thirty and forty five minutes, followed by consistent poking until it was evident that the bricks contents had reached maturity. Firing was then stopped and the kiln was allowed to cool down for several hours before the bricks were offloaded.

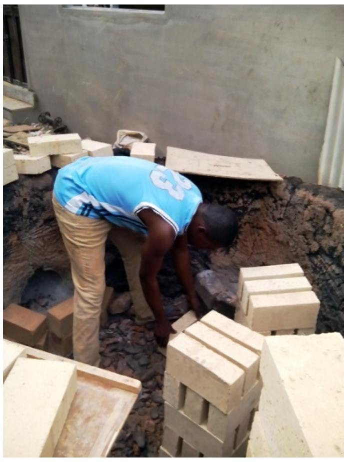

Figure 16 Stalking of bricks for firing. Photograph by Akinde, 2015.

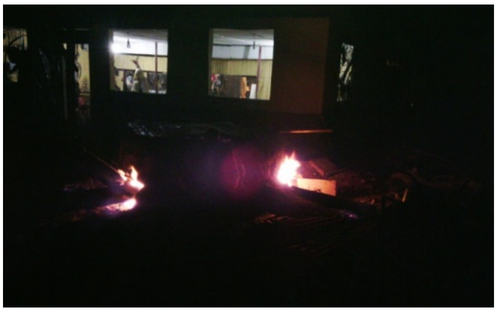

Figure 17 Kiln firing in progress. Photograph by Akinde, 2015.

Figure 18 Offloading of fired bricks. Photograph by Akinde, 2015.

5 Conclusion

From the foregoing, it is clear that earlier attempts at improving productivity of fired or burnt brick industries either by governmental or academic initiatives have not been sustainable. More so, these initiatives were geared solely at sustaining the plants, jettisoning alternative solutions to relieve the fired brick shortage that might compare favorably with the orthodox approach. As such individual fired brick domestication is extrapolated from the Yoruba maxim:

Tin tin
Kese…

Drop, droppings
Forever…

The above lines refer to the humble, unassuming beginning of the endeavor, which to a large extent guarantees sustainable productive source of income. It is therefore the belief of this study that the appropriate application of the theory of individual fired brick domestication will go a long way in empowering individuals to become employers of labor, particularly when its ontology, epistemology and methodology are well articulated.

Disbursement of funds in the form of grants or soft loans to interested individuals or groups by directorates, agencies and foundations will not only help in obliterating social vices but promote parity in benefactors by creating credible open access that embraces all comers. Also the National Directorate of Employment (NDE), Small and Medium Scale Enterprises Development Agency of Nigeria (SMSEDAN), Subsidy reinvestment and Empowerment Programme (SURE-P), National Economic Empowerment and Development Strategy (NEEDS) and Tony Elumelu Entrepreneurship Programme (TEEP), to mention only a few, can tap into this initiative by setting up training centers in Nigeria's rural and suburban localities, possibly through local governments. Especially in areas where clays are deposited in large amounts; a capital of only fifty thousand Naira (*50,000.00) may be all that is required to construct a mould and set up the aforementioned outfit. This is believed to foster productivity when fully harnessed and can translate to individual frugality and boost communal and national economy; an alternative approach that is believed to thrive in similar ecologies when adopted.

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