SHALLOW GROUND WATER DEVELOPMENT
(TUBEWELL & WASH-BORE DRILLING TECHNOLOGY) FOR SMALL SCALE IRRIGATION DEVELOPMENT IN FADAMA
(A CASE STUDY OF KEBBI STATE ADP).

BY:

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REG. NO. 1999/2000/94.

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AUGUST, 2001.

DEDICATION

This project is dedicated to my beloved father (Alhaji Husaini Muhammadu Modi Kalgo), my mother (Malama Aishatu) and the entire family.

ACKNOWLEDGEMENT

To God I am most thankful for giving me the chance and ability to face these challange.

I heartly acknowledge the contributions of my H.O.D. and Supervisor (Dr. M.G. Yisa) whose guidance through constructive cristisms and easy accessibility despite tight schedules have made possible the compilation of these work.

My thanks will go to Dr. N.A. Egharevba for his concern and contribution, as well as Dr. Adgidzi D., Mr. B.A. Alabadan, Mrs Osunde, Mr. Chukwu, Mal. Bashir and the rest of the entire staff of the department.

May God reward them all.

Umaru Husaini Kalgo
May, 2000.

APPROVAL PAGE

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ABSTRACT

Small scale irrigation schemes in the A.D.Ps has water source mainly from the perennial stream, ponds, rivers and hand dug wells. Each farmer, using his pump can irrigate 1-2 ha of fertile fadama land to produce assorted vegetables and crops like fresh tomatoes, sweet and hot peppers, onions, rice and wheat etc. At a distance beyond 100 metres from the source of water, however, farmers began to encounter difficulties in conveying water and this results in higher cost s of farm operations. The need to explore more water source or develop simple and economical conveyance techniques thus arose. However, in order to achieve these, there are many technologies introduced in the A.D.Ps for the shallow ground water exploration in the fadama land to simplify or, minimize water conveyance costs for the small scale farmers viz: Bailers system, Wash bores, Rotary drill and percution drill rigs. A tube well or wash bore can be sunk at a higher point of the farm to enable easy gravitational water conveyance to the farmer.

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CHAPTER ONE

1.0 INTRODUCTION

Water plays an important role in life. It is the greatest gift to man and essential to both plants and animals.

The establishment or otherwise exploitation of the genetic and environmental capacity of crops grown during dry season is reliant on ground water that is often lifted for irrigation purpose.

Ground water as a source of water supply has been known to man almost from the beginning of history. We are all familiar with wells (both shallow and deep) manually dug for drinking water supply.

1.1 IRRIGATION AS AN AGRICULTURAL OPERATION

Irrigation is basically an agricultural operation, which involves artificially supplying the need of plant for water. To the agriculturalist it is a component of successful crop husbandry in a dry climate, ranking with the application, and the provision of drainage.

At present more than 10 thousand hectares are being developed for dry season irrigation agriculture under the National Fadama Development Project (NFDP), through exploitation of shallow ground water using motorized pumps in Kebbi state. The sustainability of this programme

In many countries agricultural land and water sources are widely seperated. The conveyance of water requires extensive and costly engineering works but, from the agricultural view point, the means of conveyance are significant only in so far as they affect the availability, cost and quality of the water and the extent to which their physical presence impedes farming operations.

1.2 ***THE NEED FOR IRRIGATION***

Irrigation is necessary in a dry climate, or where natural rainfall does not meet plant water requirements during all or part of the year. There are many desert area in the world where the land is potentially fertile but there is virtually no rainfall. Irrigation is clearly a pre-requisite for agriculture in such places; but there are other climates in which irrigation is not essential but yet can serve a very useful purpose. There are those with dry season in which irrigation extends the growing period and so enlarges the range of crops possible or improved the yield of existing ones, and there are those with unreliable rainfall in which irrigation serves as an insurance against crop failure. Bruce W. and Staley V. (1974).

Traditionally, irrigation is carried out using "shadoaf" to lift water from channels, wells with very limited head. However, this led to the idea of fadama irrigation development employing mechanized lifting devices such as motorized pumps.

largely depends upon the long term availability of shallow ground water during the dry season.

1.3 JUSTIFICATION

(a) The successful establishment of a ground water source is a product of appropriate construction method of tubewells and washbore depending on suitable site selection guides and good spacing system.

(b) In the past, huge capital intensive government owned and managed large scale irrigation schemes have failed over time but are today being substituted with small scale farmers' owned and managed irrigation schemes (Tube-well & Wash-bores).

(c) To reduce unemployment and rural migration.

1.4 AIMS AND OBJECTIVES

(a) To give a guide to tube-well and wash-bore drilling in small scale irrigated areas in Kebbi state.

(b) To assist in creating awareness on the use, maitainance, utilization and development of tubewells and washbores in the state.

1.5 GROUND WATER OCCURANCE

The rain that is received by a drainage basin partly parculates downwards in soil and bedrock, part evaporate and the rest run-off as streams and rivers. The infiltrated water in the bedrock is Ground water. The run-off of surface is streams and rivers.

Muhsin (1980), report that in United States, an average of 30 inches of rainfall per year; of this amount 21 inches are return directly to atmosphere by evaporation transpiration and 9 inches run-off in streáms and rivers to the sea. The amoúnt of water entering by infiltration is slightly perhaps 1/10th of an inch per year. The little fraction entering into ground every year for thousand of years have accumulated as reservoir of ground water. The water we now draw from wells and springs is replenishing by rainfall every year.

Advantage of Ground Water

(a) Under ground supplies represent the largest accessible store of fresh water on the Earth. They also frequently provide the best in some cases the only solution to the problems for providing water for drinking and irrigation in the third World.

(b) It is the only source of water in some area.

(c) Ground water represents a major proportion of the Earth usable water resources. The natural cover of soil and rocks provides ground water with considerable protection.

Disadvantage

*Gound water dispite its many advantages has one serious disadvantage, it is not uniformly distributed through out the Earth crust, there are large areas around the world where ground water cannot be obtained in sufficient quantities. (**Plata, 1977**)*

Alluvial deposits along the flood plains (fadama) of major and minor rivers in the State constitute the main sources of ground water for small scale irrigation. Water bearing sand and gravel acquifers are within 15 metres (m) of the surface and water levels are generally less than 6m below the surface.

To obtain large discharge to meet irrigation purpose, tubewells are drilled into alluvial deposits intercepting one or more water bearing strata. A screen or perforated casing is required to hold back the previous material and to allow water enter the well from the acquifer. The design of this element requires careful consideration of hydraulic factors that influence well performance (Hydraulic Conductivity).

Ground water development for small scale irrigation gained prominence only in the last decade. It is the major focus of ADPs all over the country now in the development of the vast flood plains that bound along Nigeria's river system especially in the Northern part of the country where rainfall season is limited.

However, the main emphasis of this project is on an appropriate construction method of both tubewells and wasbores, spacing and site selection guidelines, base on various shallow ground water survey, researches and pappers *presented by the specialists during seminars and workshops of ADPs all over the country.*

During the early 80s, the Federal Government of Nigeria realized that large scale irrigation schemes were not yielding the desired result probability due to uncompleted infrastructure such as land grading, layout, drainage etc. The benefit realized from these large scale irrigation schemes were too small as compare to their cost of construction. Hence the Federal Government of Nigeria focused its attention toward the development of small scale irrigation scheme through the method of shallow water irrigation by tubewells and washbores system in the fadama land through the Agricultural Development Projects (ADPs), which are tripatite funded i.e by World Bank, Federal and State Governments. (Nasim, 1993)

CHAPTER TWO

LITERATURE REVIEW

2.1 In the early 1980s, the development of shallow ground water for small scale irrigation on the flood plains of the larger river in the Northern State of Nigeria was initiated within the scope of the agricultural development programmes. Initially, the main emphasis was on development of appropriate construction methods. Sites were selected primarily by trial and error and although satisfactory results were obtained on the fadamas associated with the major rivers, numerous sites were unsuccessful, particularly in the crystalline rock terrain.

Moreover, although it was apparent that the potential for expansion of small scale irrigation was enormous, there was no reliable estimate of the area with potential for exploitation of shallow ground water, nor guidelines establishing the quantity of water that could be safety extracted by suitable spaced tubewells. By the end of 1986 over 700 tubewells had been constructed in former Sokoto State (which covered present Sokoto, Kebbi and Zamfara States). These achievements was made by the ADP through the in-house drilling operation exercise.

The need for a comprehensive study to delineate appropriate areas and to determine the quantity of water that is potentially available was recognised by Programme Planners in 1984. Term of reference were prepared for consultancy services to undertake the evaluation. Warddrop Engineering Inco. was selected in late 1986 by Sokoto Agricultural and Rural Development Authority (SARDA) to undertake a 12 month investigation termed the Sokoto Fadama Shallow Ground Water Study.

The study commenced in February, 1987. The objective as set out in the Terms of Reference were to:-

(a) Delineate Fadama lands with potential for extraction of water for irrigation from shallow tubewells.

(b) Established guidelines for assessing the suitability of specific site on a fadama for construction of a shallow tubewell.

(c) Determine the seasonal water level flunctuations in the shallow aquifers beneath th fadama

(d) Determine the hydraulic characteristics of the shallow aquifers beneath the fadama

(e) *Establish guidelines for the tubewell spacing.*

(f) *Estimate the amount of water that can be safely withdrawn from the shallow aquifers.*

(g) *Determined the suitability of the water obtained from the tubewells for irrigation.*

(h) *Evaluate the various tubewells construction techniques and alternative designs.*

Kebbi State was curved out of the then Sokoto State in August 27, 1991. The State is made up of the former Western Zone and some part of Central zone of the defunct Sokoto ADP. Kebbi Agricultural and Rural Development Authority (KARDA) was established by Edict No.3 of 1991 which came into effect on 23rd December, 1991 for the purpose of carrying out intergrated development of agriculture in the State.

The ADP is made up of four zones viz:-

Zone one (1)	*with Headquarters at Argungu*
Zone Two (2)	*with Headquarters at Bunza*
Zone Three (3)	*with Headquarters at Zuru*
Zone Four (4)	*with Headquarters at Yauri*

In 1993, the Federal Government of Nigeria and IBRD (World Bank) formally signed a loan agreement for the take up of National Agricultural Technology Support Project (NATSP) and the National Fadama Development Project (NFDP) in the five ADPs in the country namely Sokoto, Kebbi, Kano, Jigawa and Bauchi.

The two projects aimed at increasing productivities of major rainfed and fadama crop farming income of the beneficiaries and raise the living standard of the farming families, these objectives are to be achieved through developing of small scale irrigation, strengthen the agricultural technology. **Anon (1994)**

Initially fadama small scale irrigation system were introduced by the poincir ADPs of Bida (enclove) Bauchi, Sokoto and Kano to develop the vast fadama lands *(flood plain) which could not be covered by the River Basin Development Authority. These simple system of small scale irrigation were based on controlled flooding (construction of water control structures), bundings and inpoundings of run off and used of residual moisture to produce a second crop after the dry season has set in. The farmers were supplied with portable 2" and 3" water pumps procured through Farmers Supply Companies of the respective*

State. The introduction of water pumps served three important purposes:-

(a) It simplified the water lifting technology from manual (shadouf) to motorize.

(b) It left intact the ownership and management of the small irrigation plot in the hand of private farmer.

(c) Farmer's labour needs reduced and larger crop yileds and income accrued.

It may be note that the initial small scale irrigation schemes in the ADPs sourced water mainly from parential streams ponds and hand dug wells. At the distance beyond 100m from the source of water, however, farmers began to encounter difficulties in conveying the water and this result in a higher cost of farm operation. It was then the expert on these irrigation projects in the ADPs carrying out investigation in 1982 to ascertain the existence or otherwise of suitable acquifers (ground water) beneath these flood plains and to establish appropriate technology for explorating them. A low cost technology of drilling tubewell and washbores using the same types and size of water pumps own by the private fadama farmers are established. Since then drilling technologies were introduced and adopted in almost all the Northern State ADPs. ***(UMAR & CALI, 1994).***

2.2 BASIC OF GROUND WATER HYDROGEOLOGY

Three main groups of geological formations recognized in Kebbi State namely:

(i) Crystalline basement rocks

(ii) Sedimentary rocks

(iii) Alluvial deposits (Fadama)

The Crystalline basement rocks occupies the Southern portion of the State and covers approximately 35% of the project area. (Zone III and IV).

The most Northern portion of the Crystalline basement is drained to the North-West by the Rima River's major tributories, the Bunsuru and Gagere. The Central area is also drained to the North-West by the Sokoto River and small tributories. In the Southern area, drainage is through Zamfara and Gulbin Ka Rivers, which discharge into the Sokoto Rima and small tributories discharging directly into the River Niger.

The Crystalline rocks are very old and according to studies by various Consultants, are said to underlie about 50% of Nigeria. Ground water yields from boreholes drilled into these rocks indicate that even where they are close to surface, they can not meet the purpose of irrigation.

Sedimentary rocks are also quite old and include sand stones, shales and limestones of these, only sand stones are high yielding formation but where they occur, their waters cannot be extracted by centrifugal pumps because of sunction head limitations. Therefore, sedimentary rock are not considered to be suitable for irrigation. It covers approximately 65% of the project area (Zone I and II)

Alluvial deposits underlie the fadama lands or flood plains of the main river systems of Nigeria. They are comprised of sand and fine gravels, silt and clays often the sand and fine gravels are water bearing and are within the reach (less than 9 metres from the surface) of centrifugal pumps. They therefore constitute the key geological formation being exploited for small scale irrigation through ground water development in Nigeria.

Alluvial deposits are formed as a consequence which results in both erosion and deposition processes. The moving water carries clay silt, sand and gravel size particles which are eroded where a stream has high energy due to a relatively steep gradient. When the stream has insufficient energy to carry the suspended debris, deposition occurs. The flow regime of a river change along its length and laterally which results in a complex depositional environment.

Flood plains are formed through several years of seasonal alluvial desposition. They are of significant occurance along major rivers of Nigeria particularly in the Northern States, but they varies in width from one water shed to another. Therefore, when we mention fadama, we refer to flood plains form through a geomorphological phenomenon. Fadama land are typically low-laying and underlaid by extensive acquifers which are hydraulically connected to river systems and are thus largely rechargeable. ***Tyem (1994).***

Geological formation in relation to their role as acquifer can be classified as:-

(a) Unconsolidated Sediment
(b) Porous rocks
(c) Fracture rocks

2.3 ***UNCONSOLIDATE SEDIMENT:***

Unconsolidate Sediments are generally considered to be the most important formation from a ground water point of view. The pore spaces in sediment such as sand and gravels provide very good storage or ground water and under favourable condition the water can be extracted from them at high rates for irrigation, industries and town water supply purposes.

Consequently, depth of aquifers in such sediment may range from near surface to 300m or more, and yield 0-100L/s. **(Mankur N. Tyem).**

2.4 ***FRACTURED ROCKS:***

Fractured Rocks have secondary porosity by virture of opening due to joint, fractures or poulding cause by the process such as folding, faulting or floxing or in the case of igneous rocks cooling, weathering and solution effect commonly scrue to enlarge these openings.

2.5 ***CONSOLIDATED ROCKS:***

Consolidated rocks usually retained significant primary porosity since it is sedimentary rocks mostly sand stone and some limestones. But the process of consolidation on sedimentary rocks involved some reduction in their initial primary porosity because of the compaction and cementation. **(Plota, 1977)**

2.6 ***AQUIFER***

Aquifer constitute layers of rocks sufficiently porous to store water and permeable enough to allow water to flow through them in economic quantities. Aquifers are two types.

(i) Unconfine Aquifers (water table aquifers

(ii) Confined Aquifers (Artesian aquifer)

(i) ***Unconfined Aquifers (Water Table Aquifers):*** *The water table (phreatic) surface is at atmospheric pressure. The recharge is proportional to the amount of rainfall. The water table rise and fall in wet and dry seasons respectively, eg. in Niger State about 35 to 40% of mean annual rainfall infiltrates into ground to contribute to the ground reserviour.*

(ii) ***Confine Aquifers (Atesian Aquifers):*** *The recharge is not directly from rainfall amount nor seepage above it. It is an aquifer that is between two impermeable layers. Hence the water is under pressure if the pressure in the aquifer is high the water can gush out to the surface.*

Types of Confined Aquifers

(i) ***Aquiclude:*** *the confining layer has very low permeability (transmit little water)*

(ii) ***Aquitard:*** *there is appreciable vertical flow component but very limited permeability.*

N.B.: SEMI CONFINED AQUIFER: *It is an aquifer that is confined by aquitard*

CLIMATE FEATURE

The climate is semi aridd with prolonged dry season period extending normally from October to April and wet season from May to September.

Information from the Water Resources Ministry shows that rainfall begins from the month of April and toward September. The average rainfall is about 600mm in the Northern region which increases to 1200mm in Southern parts. The average mean annual rainfall is about 673.84mm.

The earliest part of the dry season tends to be the coolest time of the year i.e. November to February each year and sun attained high temperature from 25^{0}C. to 45^{0}C.

The relative humidity is as low as 12% in the month of August. The average evaporation is about 400mm. Normally the wind blows South-West during rainy season and blows North-East during harmattan.

2.19 *HYDROLOGY*

Although Kebbi State has a relatively limited rainfall. It is well in endeavoured with surface water with River Rima. River Zamfara and their tributories which drain in River Niger in Kebbi State almost all rivers are perennial except River *(iii) AQUIFUGE: the confined layer are impermeable (class lecture).*

2.7 ***WATER TABLE***

A soil may rapidly take a rain water after a dry period. The water move down ward and reaches a level where rocks are already saturated water. This level is called "Water table". The water table usually takes the shape of the topography of the area though in a subdued form. The depth of water table from the surface can be observed in the walls and it flunctuates with rainy and dry season. The permanent saturated zone may extend up to 2000 to 3000ft below which rocks is dry. See fig. 1.

2.8 ***GENERAL DESCRIPTION OF THE STUDY AREA***

Kebbi State is lies in the North-West part of Nigeria between latitude ,10.00 and 13.45 and 50 cost. It is one of the new States created in August 1990. Covering a land area of . The State comprises of 16 Local Government Areas, in which 85% live in rural area, less than 5000 inhabitant (Kebbi State Office of Statistics).

Kebbi State has a gentle rolling topography under laying by crystalline basement rocks, where laterite hard paw are found at variable depth. The average elevation is 300 metres in North-West and 400 metres in the South-East.

Rima, much of the Rima run off collect in pods and lakes where evaporated or perculated to rechorge ground acquifer.

The State is divided into two geological zones, the basement complex is in the North-Western half, which may further be subdivided into five main land form to uthology and geological structure. ***(Ministry of Survey Kebbi State)***

2.9 BASIC ACQUIFER CHARACTERISTICS

It is important to note two characteristics of acquifers, Porosity and Permeability:

Porosity is a description of how much space there is in the acquifer to store water. Permeability or Hydraulic conductivity of an acquifer is a determination of how easily water can flow through. Typically unconsolidated formations like sand, gravel or their combination have high porosity and permeability rates. However, clay has high porosity but very low permeability. Consolidated formations such as sandstone, limestone are known to be very productive. In consolidated formations, water flows through cracks, pores, fractures and channels.

2.10 POROSITY

Porosity is dependent upon the size, shape and arrangement of the grains of the rock. Large size, rounded shape and wall sorted sand stone have a porosity of about 30%. Small size angular shape and unsorted sedimentary rocks have less porosity. The ability of rock to transmit water depend upon pores space plus pores connections and called **PERMEABILITY.**

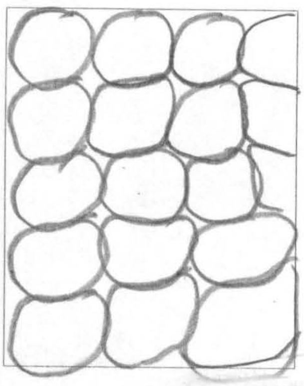
A shale layer may have 19% pores but having no connection between the pores is impermeable. On the other hand granite may have no pores but joints provide channels for rain water to penetrate deep and flow through the joint system thus making the rock permeable. All rocks in the upper part of the earth's crust, whatever their type, age or origin, contain open called pores. **MUHSIN (1980).**

2.11 PORES OR VOID

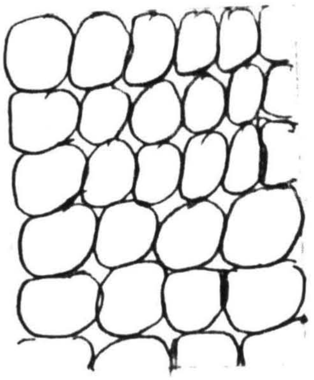
The presence of Pores or Void in a rock are essential for the perculation of rain water. For the free movement in the bedrock these pores ought to be connected. The amount of pore spaces related to total volume of rock is termed as Porosity and expressed as

$$\text{Porosity} = \frac{\text{Pore Volume}}{\text{Total Volume of x100}}$$

See fig. 2 (A-B)



A Spherical grains packed in such away that Voids or Pores make up appropriately 40% of the volume



B Spherical grains packed in such a way that Voids makes not morethan 20% of the volume.

Recharge of acquifers underlying the floodplains occurs through the infiltration of water from the river during the rainy season when the water level in the river is high. Although there is rarely a direct lateral hydraulic connection between the river and the fadama, acquifer, one can note that as former channels of the river there are points at which the acquifer (old channels) intersects the present channel. These are the areas where recharge occurs most efficiently.

2.12 HYDRAULIC CHARACTERISTICS OF WATER WELLS

Reference may be made to figure 1 in understanding the definitions that now follow. It is assumed that a well has been drilled and duely installed. When water is pumped out from the well, the water level in this well is lowered. Certain hydraulic characteristics of steady state flow in the penetrating well could be described.

The level to which water rises in a completed well, measured from the ground surface is referred to as the static water level. When water is being pumped out, the amount of drop in the water level is called drawdown. Drawdown or depression head is maximum at the well and reduces as the distance from the well increases. It is the arithmetic difference between the static water level and the pumping water level (level of water when pumping is in progress). Also, it is under the depression head that water percolates from every direction to replace the water pumped from the well. At a certain distance away from the well, the drawdown approaches zero. The distance from the central line of the well to a point where the drawdown is essentially zero is called the radius of influence. The funnel-shaped volume within the radius of influence where the acquifer is dewatered within the cone of an unconfied formation is the cone of depression.

2.13 WELL DESIGN AND CONSTRUCTION

2.14 Washbore/Tubewell/Borehole Clarification

A washbore and a tubewell mean basically the same thing. The only difference is in the method of constructing the well. Often, tubewells are deeper than washbores and are drilled with rotary rigs while washbores, as the name implies are bored with pressure of water at the bit end. Washbores and tubewells are completed in shallow acquifers particularly in fadama.

1. *accessibility to fadama site*
2. *Number of interested and capable farmers in the area.*
3. *Water supply*
4. *Cost-benefit considerations*
5. *Availability and quality of irrgatable land*
6. *Proximity to markets*
7. *Degree of social, political and environmental impact*
8. *Manpower available for tubewell and irrigation construction, operation and maintenance.*

Tubewells/washbores Spacing

Preliminary estimate suggested that tubewells spacing as little as 25-50 metres would be suitable for the aquifers depending on hydraulics characteristics and on gound water withdrawal rate.

Design Criteria

Single tubewell or washbore is a simple installation. However, the most common problems encountered with the construction that can lead to future operation and maintenance problems centre on the following design considerations:

(i) Casing selection - what material?

(ii) Intake design - screen slot opening

(iii) Casing diameter

(iv) Formation seal (grouting requirement)

(v) Gravel packing

(vi) Well development

(vii) Well testing

(viii) Gravel packing

(ix) Well log sampling and analysis of formation material.

(x) Capping

2.16 ***Selecting the Appropriate Tubewell/washbore Method***

Selection of the appropriate tubewell construction method depends on (not ranked):

(a) Flexibility of equipment to deal with the different geological conditions.

(b) Rate of tubewell completion with equipment

(c) Cost of installation (cost of equipment, cost of operation etc)

(d) Availability of inputs and spares for the method

(e) Ease of technology transfer to local artesian

(f) Level of technical expertise required in operating the drilling equipment.

2.17 *Method of Tubewell Construction*

No	Method	Estimated Cost Per Tubewell
i.	*Clear water washbore*	*₦6,000*
ii.	*Mud washbore*	*₦7,000*
iii.	*Baildown method (bailer, method with working casing)*	*₦8,000*
iv.	*Rotary rig*	*₦12,000*

The unit cost of construction of a tubewell as given above is only guide as it is valid for a particular state where the data was compiled in 1992. It therefore, should not be universally applied. One may also wish to caution that as already clarified in section 3.4, other factors apart from cost, combine to influence the choice of a tubewell method for a particular situation.

2.18 COST ANALYSIS FOR THE CONSTRUCTION OF 12METRES TUBEWELL/WASHBORE

Size	Pressure	Quantity	Cost ₦ : K
(1) TUBEWELL			
4"	10' pressure PVC casing pipes	2No.	3,000.00
4"	10' pressure PVC screen pipes	2No.	5,000.00
	Drilling chemical (GSP)	1kg	1,000.00
4"	End cap and double socket coupler	1No each	1,000.00
	Fuel and lubricants		2,000.00
	Labour		2,000.00
	TOTAL		**14,000.0**
(2) WASHBORE			
2"	10' pressure PVC casing pipes	1.5 length (9m)	2,250.00
2"	10' pressure PVC screen pipes	3metres	1,800.00
2"	End cap and socket coupler		500.00
	Fuel and lubricants		500.00
	Labour		1,000.00
	TOTAL		**6,050.00**

CHAPTER THREE

CONSTRUCTION OF A TUBEWELL/WASHBORE - CLEAR WATER WASHBORE METHOD

3.1 MATERIALS REQUIRED FOR CLEAR WATER WASHBORE METHOD (WASHBORE JETTING)

i. 2No, 2inch petrol engine driven pumps complete with sunction and delivery accessories (hoses, clips, strainer, couplings)

ii. 5m sunction hose (additional)

iii. Additional 10 metre delivery hose

iv. 2" G.I. Pipe, medium quality cut into (a) 2No, 6m lengths with socket at one end of each
(b) 1No., 3m length with socket
(c) 2No., 2m lengths with socket
(d) 3No., 1m lengths with socket

v. 2" brass coupling 3 pieces

vi. Tangit gum

viii. 2" G.I. elbow

ix. 2" plastic coupling

x. Two heavy duty pipe wrenches, 24" and 18" sizes

xi. One 3" to 2" G.I. reducer

xii. 3" G.I. 6" long

xiii. Tool box

xiv. 2" G.I. bend with male and female ends

xv. 2" plastic coupling

xvi. Miscellaneous items such as digger, shovel, head pan, hacksaw with baldes, measuring tape

xvii. Coarse sand
xviii. PVC Screens
xix. PVC Casings - 50mm or 63mm size.

2 ***PROCEDURES FOR WASHBORE JETTING***

Step I:

Drill pilot hole with hand auger removing the top clay and silt preferably down to close to water bearing sand. Measure the depth of water table to decide whether or not to proceed further. This could also be achieved if a proceed further. This could also be achieved if a reconnaissance survey is carried out in the area to establish that ground water is available within 1-9m from the surface.

Step II:

After having established the site, decide whether to reuse the filling water or not, if the water is to be reused dig a pit 1mx0.7m approximate some 3 to 4 metres from the pilot hole.

Step III:

Assemble the filling pipe 3 to 4 metres with G.I. bend and drilling bit

Step IV:

Assemble the pump with sunction hose, strainer and delivery hose connected to G.I. bend.

Step V:

Hold the G.I. pipe vertically with the help of a plumber and 3 labourers at the top of the test hole or about 0.5 metre inside the hole.

Step VI: ·

Start the pump. The drilling operation is performed by jetting a stream of water under pressure and washing the cuttings. Ensure all cuttings are removed before lowering the pipe further. If the penetration is difficult, apply a downward reciprocating thrust by lifting and dropping the pipe continously. By this method, it could be possible to penetrate through the bases of clays when encountered. When the three metre penetration is achieved remove the 3m filling pipe and change it to 6m and continue drilling, then change to 9m and continue drilling. The change now should be achieved with minimal loss of time. When penetrating the acquifer, the pipe will have the tendency to go down on its own. Examine the cuttings closely for the best available formation of coarse sand and gravel. When full depth of the filling pipe has been penetrated it could be possible to establish the depth at which the best acquifer exists. The filling pipe is then moved up and down while the pumping is *continued so as to bring out all the fines to the surface leaving the coarse sand and gravel where the screen is subsequently to be located. The pump is slowed down.*

<u>Step VII:</u>

Assemble the PVC Casing and screen to match the location of the acquifer.

<u>Step VIII:</u>

The jetting pipe is withdrawn and the assembled tubewell installed instantaneously into the hole.

<u>Step IX:</u>

If the hole has collapsed and the screen could not be lowered to the required level, remove the drilling bit and insert the jetting pipe close to the casing and screen and start the pump again. With the help of further jetting, lower the screen to the required position.

<u>Step X:</u>

Cut off any length which is about 25cm above the surface from the casing pipe and connect the PVC reducer to PVC nipple with 2" G.I. bend.

Step XI:

Development: *Connect the tubewell with the pump and pump clear water slowly till all the fine sand close to the screen is removed. Insert coarse sand and gravel around the tubewell with pump still running slowly, so that the coarse sand is packed upto one metre above the top of the screen.*

Step XII:

After having developed the wall, certain measurements are required to complete the record sheet. Also prepare a log of the hole.

Step XIII: *Provide a G.I. plud*

Step XIV:

After the tubewell is operated for a fortnight, provide a concrete slab 40cm x 40cm x 5cm around the well and protect. Refer to figure 2 for diagramatic representation of a tubewell.

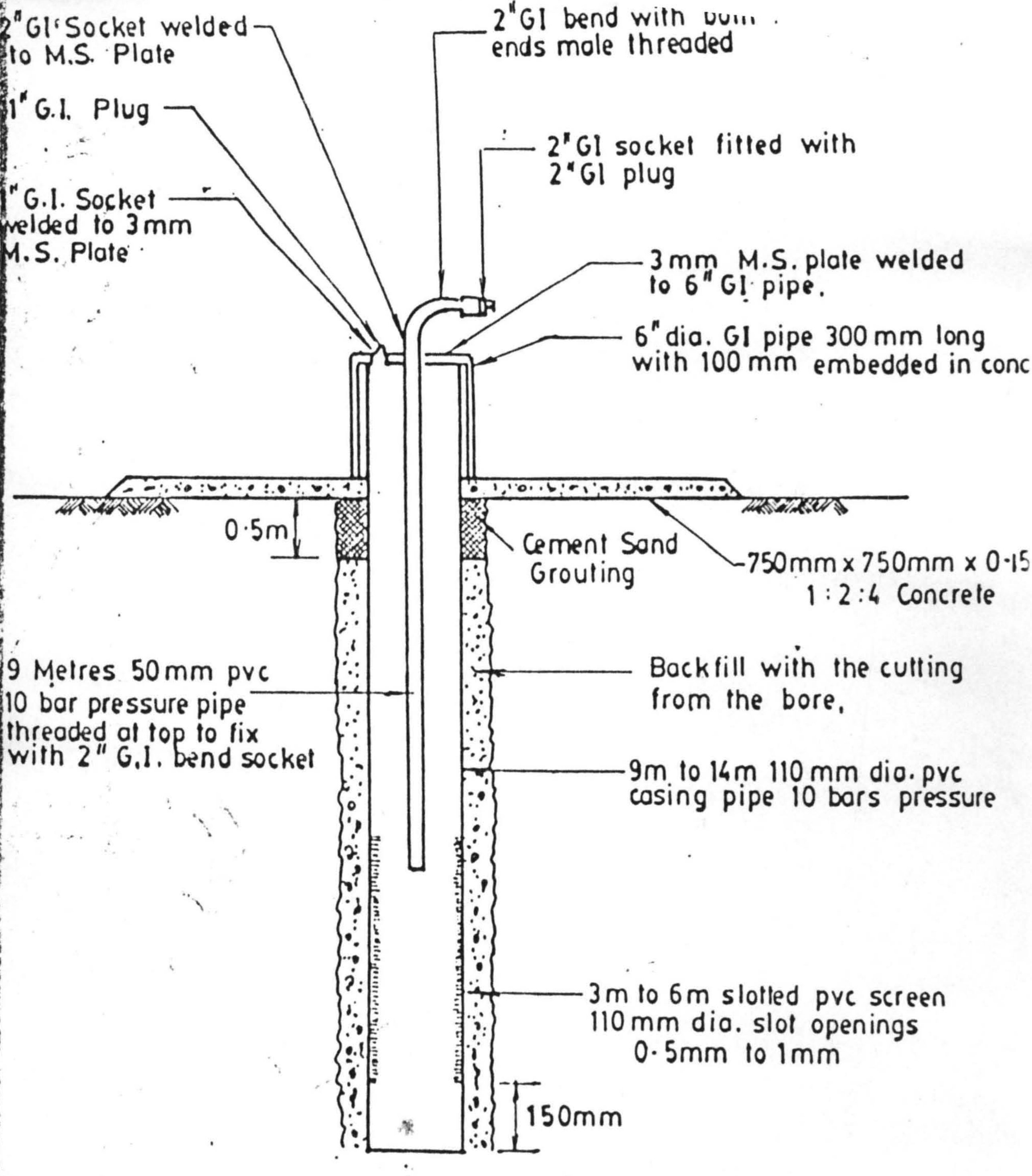


FIGURE 2: TYPICAL TUBEWELL DRAWING

(Not to Scale)

CHAPTER THREE

CONCLUSION AND RECOMMENDATION

4.1 *CONCLUSION*

Existing data, based on reports prepared by Water Resources Consultants who worked for various ADPs show that about 3.5 million hactres of Nigerian landmass are Fadama land out of which some 2 million hactres can be put under small scale irrigation. These have been classified as irrigable fadama. Fadama areas classified as having potential for full development have either parennial streams or rivers in their proximity and shallow ground water that can be exploited by simple technology of drilling and jetting. A summary of this data is represented in table below:- (Table I).

TABLE 1:

State	*Available Fadama Land (ha)*	*Potential Irrigatable (Fadama) Land*	*Area by Washboring & Tubewells (ha)*	*Area by Direct Pumping (ha)*
Borno	489,300	300,000	240,000	60,000
Yobe	450,000	365,600	322,600	33,000
Plateau	166,000	66,500	52,500	14,000
Kwara/Kogi	300,000	255,700	218,600	37,100
Kano/Jigawa	163,000	132,700	26,000	106,700
Sokoto/Kebbi	400,000	164,000	140,000	24,000
Bauchi	235,000	181,000	71,000	110,000
Katsina	46,000	26,450	20,450	6,000
Kaduna	70,000	35,000	25,000	10,000
Niger	260,000	182,000	120,000	62,000
Adamawa &Taraba	995,000 studies	are under way	to classified	these statistics
Benue	100,000		12,500	45,000
	3,684,300	**1,765,950**	**1,258,150**	**507,800**

Ref.: *Staff Appraisal Report, National Fadama Development Project, 1991 and Ground Water Studies of Repective States.*

On its effort of encouraging privatization of tubewells and washbore drilling, so as to involve private drillers into the system, to enable the ADPs meet the great demand of the farmers, which cannot be fully met with in-house drilling capacity. Kebbi State ADP has awarded a contract to the following companies for the construction of tubewells and Wash bores in the State from 1994 to date, and irrigation water pumps are equaly distributed to the beneficiaries.

See Table 2: Below.

S/No	Companies	Tubewells Drilled	Washbore Drilled	Time
1.	Chinna-geo	2400	-	94/95
2.	Bio-Invest Nig. Ltd	-	300	95/96
3.	Bakabo Nig. Ltd.	-	3300	96/97
4.	Fotia Nig. Ltd.	-	1000	96/97
5.	Bio Invest Nig. Ltd.	1160	-	97/98
6.	Asuki Nig. Ltd.	-	800	98/99
7.	In-House Teams	-	1000	99/2001

Table 2:

Total Washbore drilled = 6,560

Total Tubewells drilled = 3,400

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Note: *This shows that farmers are responding to Washbores drilling system morethan the Tubewells system because Washbore is cheaper, easy to maintain and to construct*

4.2 RECOMMENDATION

All the funding agencies viz:- The Federal Government of Nigeria, State Government and the World Bank whose interest lies in the proper identification and development of Fadama may be requested to provide adequate funds under the "RESEARCH AND DEVELOPMENT" so as to carryout research in the following sections:-

(i) Development of specific approach for the proper identification of fadama lands.

(ii) *Development of Technologies for the local manufacture of drilling equipments and irrigation pumps in order to save the huge foreign exchange component currently being used for the importation of these items.*

(iii) *Training of indigenous staff in the field of irrigation engineering and irrigation agronomy etc presently there is acute shortage of qualified irrigation engineers in the ADPs which forms major constraints in the development of fadama.*

(iv) *Training of private drillers so as to involved them in the implementation of the programmes, privatization of tubewells and washbores drilling has to be encouraged so as to meet the great demand of the farmers which cannot be fully meet with inhouse capacity.*

(v) *To impact training to the village mechanics in order to provide reliable back-up services to the farmers for the repair and maintenance of pumps.*

(vi) *To introduce solar energy which is a viable means of alternative sources of energy.*

(vii) *To introduce electricity in the fadama area in order to provide adequate cooling and storage facilities.*

(viii) *To provide training to the FUAs in water management monitoring, effective cost recovery and proper took keeping of account books and ledgers etc.*

(ix) *To conduct more research on Agro-processing in order to minimise all kinds of loses.*

(x) *Last but not the least to organise more frequently orientation training workshops in the country from on ADP to another. Research Institutes show also be invited to participate in such workshops.*

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