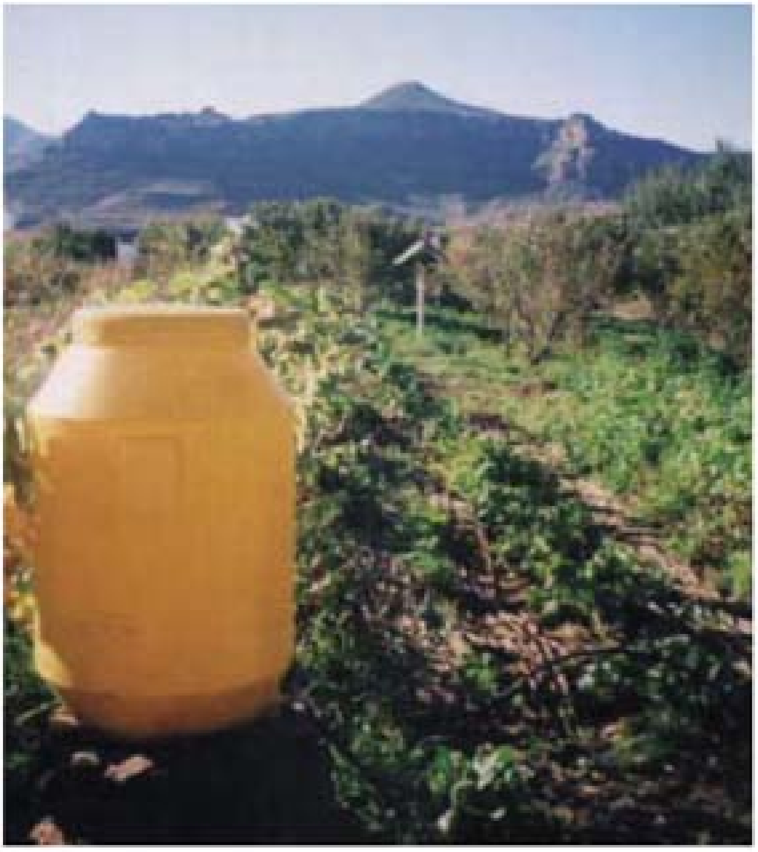
Final Report

Approprite Water-lifting Technologies in West Africa



International Programme for Technology and Research in Irrigation and Drainage

Appropriate water-lifting technologies in West Africa

Findings and proposal for a research and uptake programme

Final report

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PREFACE

WATER-LIFTING TECHNOLOGIES IN WEST AFRICA

During the period 2001 and 2002 the International Fund for Agricultural Development (IFAD) and the International Programme for Technology and Research in Irrigation and Drainage (IPTRID) discussed and acted upon the need to document the type and extent of water-lifting technologies of smallholders in West Africa. It was felt by both institutions that there was a wealth of knowledge in the region at the resource-poor communities level that was being utilized on an ad hoc basis, and more often than not disappearing within those same communities in detriment to other potential beneficiaries. IFAD and IPTRID decided to jointly collaborate in an effort to develop a programme directed towards technology transfer and, equally important, to the identification of research uptake that could be adjusted to the existing physical, socio-economic and cultural setting.

IFAD then made a generous grant of US$100 000 to IPTRID for the design and implementation of the first step of the Programme, which was foreseen to require a mid- to long-term effort. During this first phase the state of water-lifting technology in Ghana, Niger and Nigeria was documented and surveyed. The exercise was assumed directly relevant to adjacent countries such as Cameroon, Chad and Gambia. Furthermore, the expectations were that other West African countries such as Benin, Burkina Faso, Cote d'Ivoire, Mali, Liberia, etc. would derive indirect benefits from existing constraints and lessons learned in the original targeted countries.

With the above in mind, a brainstorming session was held at IPTRID headquarters at FAO, Rome. Among other things, the decision was taken to carry out diagnostic and fact-finding work that would clarify, evaluate and document situations and applications of both constraints and successful application of water-lifting technologies in the first three targeted countries. The Programme was to cover the preparation of decision-making guides on matching water-lifting technologies with specific field situations. It was also to develop quality control methods and regimes for manufacturers of equipment, prepare indicators and procedures for Monitoring and Evaluation and, last but not least, to study credit arrangements, subsidy policies and mechanisms, marketing conditions, etc.

Work proceeded on schedule in 2001 and into 2002; towards the end of that year the study was well advanced and the insights into the future water-lifting related Programme were put together. Unfortunately, at that same time, IPTRID went into a period of redefining its strategy and mandate and this particular activity suffered serious follow-up delays. IPTRID highly regrets this outcome but is engaged in bringing the activity back on track. IPTRID reached an agreement with IFAD to proceed with the publication of this Final Report convinced, as both institutions are, that the material is still valid and relevant and has not lost its importance. A follow-up will be carried out and the report is to be presented in Nigeria during a specific report-findings seminar. Afterwards, further discussions are to be held in order to seek ways to advance the proposed Programme presented in the Main Report.

IPTRID SECRETARIAT

ABBREVIATIONS

FOUND IN MAIN REPORT AND ANNEXES

AFVP	Association française des volontaires du progrès (a French voluntary organization, working with ANPIP in Niger)
ANPIP–1	Association Nationale pour la Promotion de l'Irrigation Privée (a non-profit-making association in Niger to promote private irrigation)
ANPIP–2	Agence Nigérienne pour la Promotion de l'Irrigation Privée (executing agency of the association) (both operating under PPIP in Niger and closely related to each other; in this report and its literature sources it is generally the 'Agence' that is meant)
ARC	Institute of Agricultural Engineering, Agricultural Research Council, South Africa
ARID	Association régionale pour l'irrigation et le drainage en Afrique de l'Ouest et du Centre
CIM	Composante Irrigation Mécanisée (a component of PPIP in Niger
CORAF/WECARD	Conseil Ouest et Centre Africain pour la Recherche et le Développement Agricoles/West and Central African Council for Research and Development (information can be found on http://www.coraf.org/secretariat/docmts/index.html)
CPEC	Caisses populaires d'épargne et de crédit (savings and credit)
DFID	Department of International Development (UK)
EW/EWW	Enterprise Works Worldwide (an international NGO working in irrigation development, particularly in Niger and in Mali, Senegal, and elsewhere; formerly known as AT International)
FAO	Food and Agriculture Organization of the United Nations
FCFA	Franc CFA (Communauté financière africaine), the common currency of many French speaking West African countries
GIE	Groupement d'Intérêt Économique
ha	Hectare
hp	Horsepower (1 HP = 0.746 kW)
IAR	Institute of Agricultural Research
IDE	International Development Enterprises (an NGO which, among other activities, promotes development of treadle pumps, often overcoming credit shortages by buying them from local manufacturers and passing them on to retailers on a commission basis, Kay & Brabben (2000, page 3)
IFAD	International Fund for Agricultural Development
IFAD-NSP	IFAD-Niger Special Programme
ILI	Institute of Agricultural Engineering, Agricultural Research Council, South Africa
IPTRID	International Programme for Technology and Research in Irrigation and Drainage
ITTU	Intermediate Technology Transfer Unit
JARDA	Jigawa Rural Development Area
kWh	Kilowatt-hour (1 kWh = 1 000 watt-hours = 3.6 MJ)
l/s	Litres per second (1 l/s = 3.6 m^3/h)
M&E	Monitoring and evaluation
m^3/h	Cubic metres per hour
MAIC	Component improved hand-operated irrigation
MEST	Ministry of Environment, Science and Technology (Ghana)
MJ	Mega (million) Joules (1 MJ=1 million watt-seconds or 1 million Newton-metres)
MP	Hand operated pumps
MPS	Motor pump system
NA	Not applicable
NAERLS	National Agricultural Extension and Research Liaison Services
NGO	Non-governmental organization
NWRI	National Water Resources Institute in Kaduna
PPIP	(World Bank) Projet de Promotion de l'Irrigation Privée (in Niger)
PPPI	Project for Promotion of Private Irrigation (English translation of above)
rpm	Revolutions per minute (speed of rotation)
SPFS	Special Programme for Food Security
TAG	Technical Assistance Grant
TCDC	Technical Cooperation among Developing Countries
TPT	Treadle pump technology
UNDP	United Nations Development Programme
USAID	US Agency for International Development

GLOSSARY

In this report, unless stated otherwise, the Programme means the applied research programme proposed and is explained in Chapter 1.

Names used for types of fuel in English and French are as follows (the words petrol and petroleum are avoided because they can cause confusion in Francophone contexts):

Name used in this report	Gasoline	Kerosene	Diesel
Other names in English	Petrol	Paraffin	Gas oil
Names in French	Essence	Pétrole Kérosène	Gazole

French and English names of some water-lifting technologies

Suction pump	Pompe aspirante
Pressure pump	Pompe refoulante
Centrifugal pump	Pompe centrifuge
Axial pump	Pompe axiale
Jet pump, venturi pump, ejector pump	Pompe à hydro-éjecteur
Self-priming pump	Pompe auto-amorçante
Motorized pump, engine-driven pump or pumpset	Motopompe
Treadle pump	Pompe à pédales
Rope and washer pump	Chaîne à augets, pompe à (corde et) rondelles
Carousel (animal turning in a circle)	Manège
Hydraulic ram pump (hydram)	Bélier hydraulique
Wind energy	Énergie éolienne

EXCHANGE RATES

Inflation (%) and exchange rate to the US dollars (US$) for selected countries and years:

	YEARS									
	2000		2001		2002		2003		2004	
Country	Inflation rate (Annual percent change)	Exchange rate**	Inflation rate (Annual percent change)	Exchange rate	Inflation rate (Annual percent change)	Exchange rate	Inflation rate (Annual percent change)	Exchange rate	Inflation rate (Annual percent change)	Exchange rate
Ghana	25.2	5 530.6	32.9	7 344.7	14.8	8 223.3	26.7	8 644.4	10.8	8 905.6
CFA*	2.9	714	4.0	730.3	2.7	696	-1.6	580.8	0.4	535.3
Nigeria	6.9	105.1	18.0	116.95	13.7	126.4	14.4	133	15.8	134.4

Sources:
The currency site: http://www.oanda.com/convert/fxhistory for the exchange rates.
The MFI Web Site: http://www.inf.org/external/pubs/ft/weo/2004/02/data/index.htm for the inflation rate.

* CFA is the common currency of Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Congo, Equatorial Guinea, Guinea Bissau, Cote d'Ivoire, Mali, Niger, Senegal and Togo.
** The exchange rate is expressed in the country's currency, value of one US dollar. The exchange rate provided is the average of the daily exchange rates of the given year. The currencies are: Ghanaian Cedi, Nigerian Naira and Franc CFA BCAO for Niger.

1. Introduction

The International Programme for Technology and Research in Irrigation and Drainage (IPTRID) has undertaken, on behalf of the International Fund for Agricultural Development (IFAD), a preliminary study of appropriate water-lifting technologies in West Africa. Its declared aim is ‘to design an applied research and technology uptake programme on the current status and the potential for the development of water-lifting technologies in the region, with particular regard to resource-poor communities’. The background to the study and the proposed Programme is expressed in the Terms of Reference of this report as follows:

‘Demand for water-lifting technology is strong in the West Africa region for domestic and drinking-water as well as for food production. In general, drinking-water involves the lifting of water from groundwater (often many tens of metres) but in relatively low volumes. Irrigation, on the other hand, is supplied from surface waters or shallow groundwater but in much greater quantities. Irrigation ‘consumes’ about 87 percent of the water withdrawn for use in the region. Technologies that can improve the efficiency of lifting and using water for irrigation can reduce waste and release more water for other sectors, particularly domestic use, and improve crop husbandry and production.

‘It is evident that the water-lifting technologies in use in West Africa are limited in their application due to a combination of technical, economic and social reasons. Some of the more evident reasons for the low rate of uptake are purchase price, running-cost and lack of support services for maintenance, repairs and spare-parts. There is a pressing need to identify opportunities, constraints and appropriate actions on water-lifting technologies, for agriculture, in the region. The successful use of surface and groundwater by resource-poor families depends greatly upon their access to appropriate water-lifting technologies and the availability of suitable sources of water.’

The preliminary study began with rapid field data collection and assessment in three parts of the West Africa region: Niger, Ghana and the northern states of Nigeria. The aim of these exercises was to:

- review the current status of water-lifting technology,
- collect information on water-lifting projects in the three areas, and
- collect information on each region’s manufacturers, suppliers, importers and exporters of water-lifting technology.

The information-collecting reports were prepared by others, independently of this study. They can be found in Annexes D, E and F. These reports were followed by a brainstorming meeting in Rome on 18 and 19 October 2001, leading to this present document.

This report presents the work done for IPTRID in preparation of the Programme. Its objectives (which were extended in December 2001 after the completion of a preliminary study report) were to:

- review the status, problems, issues and potential of water-lifting technologies in the region;
- identify the priorities for intervention and research to minimize the constraints and to take advantage of identified opportunities;
- draft a research proposal, with logical frameworks, costs estimates, time schedules, and suggestions for the programme’s organization, management, and financing; and
- make suggestions for practical indicators to measure the impact of improved water-lifting technologies on food production and livelihoods.

Chapter 2 discusses the scope of the Programme, and hence of this report. Chapter 3 describes the available technologies and the criteria for choosing between them. Chapter 4 summarizes the information gathered so far on the status of water-lifting and water-lifting technology, and its future potential. Chapter 5 discusses the relevant problems, constraints and issues and Chapter 6 presents the resulting proposals for the content of a research and uptake programme. Proposals for the Programme's implementation, management and financing are in Chapter 7. Finally, Chapter 8 discusses indicators to monitor progress. Background information on West Africa (from other authors) is in the Annexes D, E, F and G, while the other Annexes give details supporting the chapters.

2. Scope and aims of the programme

It was agreed at the brainstorming session on 19 October 2001 that this report and the Programme should cover water-lifting technologies appropriate for irrigation of units up to about 30 hectares (ha). This is to include most of the range of smallholder farmers in West Africa, and the smaller village schemes, though most applications will involve less than 1 ha. Also included are any water-supply applications that may fall into a similar range of lifts and discharges.[1] They therefore do not cover water-lifting for larger irrigation schemes, such as the formal state-sponsored schemes, nor the 'informal medium-sized irrigation schemes' of Ghana.

The scope of the Programme depends on what is meant by the word 'appropriate' in this study's title. It is assumed that in this context it means that water-lifting technologies should be cost-effective, sustainable (technically, financially and socially) and replicable. To achieve these aims a water-lifting technology needs to be well matched to the local situation and to the application, i.e. to the job that needs to be done. Many of the problems with newly introduced technologies have been the result of bad matching, for instance using motorized pumpsets at much less than their design head and/or speed, or using the wrong sort of treadle pump. This report therefore starts with the concept of **matching technologies to applications and situations.** The matching is between the supply side and the demand side of water-lifting, as shown in Table 2.1; the supply side is represented by location-neutral technologies, and the demand side by location-specific applications and situations.

It is significant that the Programme is required to cover both **applied research and technology uptake.** Uptake means the process by which information is delivered in a useable form to the people who need it, in order that water-lifting technology may be well chosen, delivered, and maintained. This report therefore covers uptake promotion, training, communication and dissemination as well as research.

It is assumed that for this report's purposes West Africa comprises Benin, Burkina Faso, Cape Verde, Cote d'Ivoire, Gambia, Ghana, Guinea, Guinea Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone and Togo. The proposed Programme's outputs on the 'supply' side would be useful for adjacent countries such as Chad and Cameroon, and to a considerable extent for the whole of Africa.

[1] Some village schemes are larger than 30 ha; however they are often best operated as several pumping units of around 20 ha each.

TABLE 2.1 Framework for consideration of appropriate water-lifting technologies

Supply side (Technology-specific)	**Technology**: a water-lifting technology is characterized by the: • type of power source (human, animal, electric motor, petrol engine, diesel engine, solar, wind, etc.); • type of pump or lifting device (bucket, calabash, piston pump, diaphragm pump, progressive-cavity pump, close-coupled self-priming centrifugal pump, submersible pump, axial or mixed-flow pump, etc.); • delivery arrangements (water dropped into a channel or reservoir next to the pump, or delivered under pressure into a pipe); • resulting technical characteristics, such as the optimum discharge and head, energy-efficiency under these optimum conditions, and efficiency at non-optimum conditions; • equipment's reliability, robustness, ease of maintenance, familiarity (e.g. some gasoline engines are familiar to local mechanics because they are similar to those found on motorcycles); • typical costs: initial cost, fuel or energy consumption, maintenance and repair costs.
Demand side (Place-specific)	**Application,** the job to be done: a specific water-lifting application is characterized by the: • static lift (the height of the delivery point location above the water source); • device delivery head, if any (the pressure needed after the delivery point, for delivering water to a higher or distant location, or to drive an irrigation delivery system such as sprinklers); • instantaneous discharge needed (litre/sec or m^3/h) (often limited either by the source, such as a borehole that suffers excessive drawdown if pumped too fast, or by the destination, for example an irrigator with a hand-held hose moving through a crop); • water storage arrangements, if any (provision of a small tank downstream of the pump makes pumping hours and flow rates independent of those for distribution, also enabling the resting of boreholes); • total daily volume needed (instantaneous discharge x number of operating hours per day … the hours per day may be constrained by the need to do other things, or by the stamina of the operator in the case of human-powered devices).
	Situation: the relevant conditions in the particular location; for irrigation these include: • soil and land types (affects ease of construction of washbores or other sorts of borehole or well); • nearby water resources (rivers, alluvial plains with shallow groundwater, etc.); their relative scarcity, reliability, seasonality and accessibility; • size of landholdings and degree of fragmentation; • typical farm family situations: labour availability, other time and energy-consuming activities of family members, availability of hired labour; • existence or feasibility of sustainable and effective farmer groups for shared use of a pump; • availability of fuel for engine-driven pumps; seasonal shortages; • fiscal and economic regime (e.g. tax rates on different sorts of fuel or on imported equipment); • availability of credit or subsidy, how it is structured, strength of financial institutions; • the capacity of the user; degree of mechanical skill, financial situation, access to credit, etc.; • commercial conditions, presence of entrepreneurs, dealers, mechanical workshops, etc.; • the locally available technical backup for particular technologies (advice, spare parts, etc.).

At the brainstorming session on 19 October 2001, it was explicitly agreed that the following activities would be covered by the Programme:

- diagnostic and fact-finding work to evaluate and document the situations and applications that are relevant in particular countries and regions;
- diagnostic studies to clarify the relevant constraints and the typical conditions for successful application of water-lifting technology;
- preparation of decision-making guides on matching water-lifting technologies to water-lifting applications and situations;
- collation and/or development of test methods, test reporting formats, and perhaps testing facilities for relevant water-lifting equipment;
- development of quality control methods and regimes for manufacture of relevant water-lifting equipment;
- training and capacity-building in direct relation to water-lifting technology (potentially including guidelines on the setting up of such training); and
- preparing indicators and procedures for monitoring and evaluation.

To these were added later, because of their importance,

- studying credit arrangements, subsidy policies and mechanisms, and marketing; and
- promotion of the uptake of water-lifting technologies in West Africa.

At a meeting at IFAD on 6 December 2001, the following two topics were agreed to be relevant to the programme:

- technologically sound solutions, tested in the field by sample tests; and
- linkages with other field operations, in particular those of IFAD.

Part of defining the scope of the Programme is to clarify some things it does not cover. The definition of situations in which water-lifting technology is used, as set out in Table 2.1, includes some relevant aspects such as soil and water resources, land tenure, farm family characteristics, or irrigation method. The Programme is not intended to include either research or uptake work on these topics. In particular, the following aspects, which were mentioned or suggested at the brainstorming meeting on 19 October 2001, are **not** within the scope of the Programme:

- legislation on land ownership, and on taxes;
- development of markets for agricultural inputs and products;
- ways of establishing effective farmer groups;
- techniques for constructing boreholes, washbores or wells;
- technology for the storage, conveyance and distribution of irrigation water; and
- guidelines and know-how for irrigation development.

Whether or not the Programme should include direct development of technologies was not explicitly agreed at the brainstorming session, though it was not included in the list of proposed activities. This is discussed further at the end of Chapter 6.