Bamboo-reinforced Concrete Rainwater Collection Tanks

By: Thomas B. Fricke

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Working Paper

BAMBOO-REINFORCED CONCRETE RAINWATER COLLECTION TANKS

(A project of Community-Based Appropriate Technology and Development Services in Thailand)

Thomas B. Fricke

Series editor: Diane B. Bendahmane

A.T. International is a private, non-profit corporation, created in 1977 in response to a mandate from the U.S. Congress to "promote the development and dissemination of technologies appropriate for developing countries."

THE AUTHOR

Thomas Fricke is Technology Resources Coordinator for Business and Technology Services at A.T. International. Before joining the ATI staff, he was a program associate at the International Science and Technology Institute where he coordinated environmental and appropriate technology projects. He has also been a consultant on a UNIDO mission to establish an appropriate technology center in Indonesia, a project research coordinator on a University of California small farm project, and a staff member of the Farallones Institute. Mr. Fricke served as a village technology volunteer in Indonesia for Volunteers in Asia.

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ABSTRACT

The Community-Based Appropriate Technology and Development Services (CBATDS) program has registered significant successes in the introduction and wider dissemination of technologies to provide potable water to villages in semi-arid drought-prone Northeastern Thailand. CBATDS, an auxillary of the Population and Community Development Association (PDA), has mobilized technical, logistical and financial assistance for the construction of over 1,000 bamboo reinforced concrete rainwater collection and storage tanks at the time of the field survey. The tank construction program began in 1979 with a village needs analysis conducted by CBATDS staff. The following year a pilot project proved that numerous villagers in three target districts were willing to participate in the construction and self-financing of household rainwater storage systems. Subsequently CBATDS has developed a methodology combining trained technicians, village construction teams, and soft loan financing which has yielded the current results and a projection for the construction of over 4,000 additional tanks by 1985.

CBATDS was created by PDA in 1979 to support its extensive delivery system of trained village-based family planning volunteers, district supervisors, and central office staff in the operation of broader rural development programs for improving the incomes and quality of life for rural Thais. To date, CBATDS and its sister organizations have carried out a number of promotional activities in water resource development, cottage industries, alternative energy technologies, health and sanitation improvements, agricultural extension, and alternative marketing in selected areas of North and Northeastern Thailand. Most of these programs are predicated on the participation of its family planning acceptors, volunteers and growing staff.

CONTENTS

Author's Note

This study of the Community-Based Appropriate Technology and Development Services (CBATDS) Rainwater Collection and Storage Project in Northeastern Thailand attempts to illuminate the socio-economic, technical, and organizational issues involved in technology adaptation and dissemination. The study is the result of a field survey I conducted in Thailand from February 22 through March 4, 1982. During that period, various interviews and site visitations were conducted with the field staff of CBATDS, users of technology, commercial enterprises, and other government and private development agencies in Thailand. Because of the limitations of this kind of field survey, my conclusions about this project have to be read as tentative.

A.T. International enters into support funding relationships with private agencies in developing countries primarily to enhance their abilities to evolve and promote technologies and processes responding to community needs. This assistance may be targeted for very specific predetermined technologies, geographic areas, users, and production systems, or allow for a process of experimentation and innovation which will eventually lead to more precise outcomes. In this study three key components of the technology adaptation process are isolated and analyzed in greater detail -- the sponsoring organization, the technologies involved, and the role of external assistance (if any), using a number of hypotheses developed by the staff of the evaluation department at ATI.

Although I was working as an operations representative with the Asia/Middle East team at A.T. International during the time the tank construction project was being implemented, I had no direct responsibility for the project, and this visit to the project site was my first extensive visit.

The CBATDS Rainwater Tank Project illustrates how flexible support for institutional development -- broadly defined -- can result in successful technology adaptation and dissemination.

Thomas B. Fricke
August 17, 1982
Washington, D.C.

I

THE SPONSORING ORGANIZATION

The Population and Community Development Association

The Community Based Appropriate Technology and Development Services (CBATDS) was established in December 1978 to expand and improve upon the development work of the Population and Community Development Association (PDA) and its major implementing bureau, the Community-Based Family Planning Services (CBFPS), based in Bangkok, Thailand. Since its inception in 1974 under the dynamic and controversial leadership of its general secretary, Meechai Viravaidya, PDA has extended a family planning service network to approximately 16,200 villages throughout Thailand or one-third of the country's villages. PDA is acknowledged by many outside observers to be one of the most successful and extensive programs of its kind in the developing world.

Overall, PDA has become the largest private development agency in Thailand, with a staff of nearly 500 for all its various affiliated divisions. PDA is a registered tax-exempt non-profit organization engaged in service delivery in family planning, parasite control, sanitation, general health, and community development. Generally operating in close collaboration with government agencies, it is active on the village level but also carries out projects is some urban communities.

Agencies Affiliated with PDA

The Community-Based Family Planning Services (CBFPS). CBFPS is the major bureau of the PDA and the entry point for many PDA staff. Since 1974 it has implemented community-based family planning services and activities primarily in Thai villages and some urban communities. Family planning volunteers, all of whom are long-standing community members chosen for the respect in which they are held in their villages, have been trained and deployed in 16,200 villages in 150 districts with a population of 16 million people. Activities have now been expanded to include maternal and child health, nutrition, parasite control, immunization, primary health care, and sanitation.

In other programs, the CBFPS has provided family planning, health, sanitation, nutrition, and medical information and education to 320,000 rural school teachers, 304 commercial and industrial firms, state enterprises, cooperatives, and military organizations.

PDA's greatest successes to date have been registered in CBFPS's ability to deliver goods and services (i.e., birth control pills, condoms, other contraceptives, and family planning information) directly at the village level. The network which depends upon village volunteers (who receive a commission from sales of contraceptives), district supervisors, and a Bangkok-based staff, has registered impressive achievements in generating six to eight million family planning acceptors. Government services may disperse advice and devices free of charge, but they have been relatively ineffective because people must make the effort to avail themselves of the services.

The Asian Centre for Population and Community Development (ACPD). In mid-1978, the center was established under the umbrella of PDA to facilitate the transfer of experience in community action concepts in population management and development activities among developing countries. ACPD provides a series of international training programs on community-based development. By February 1982, the center had trained over 500 participants from various developing countries, ranging from Kenya in Africa to Bangladesh in South Asia.

The Community-Based Emergency Relief Services (CBERS). CBERS was established to assist the royal Thai government in providing relief services to communities and displaced persons. In response to the Kampuchean refugee crisis in 1979 CBERS joined the United Nations High Commissioner for Refugees (UNHCR) and other international voluntary agencies in the general relief effort involving 150,000 Kampuchean refugees living in holding centers in the eastern and northeastern sections of the country.

Programs offered by CBERS range from family planning, parasite control, preventive health education, traditional medicine, and comprehensive sanitation services to agriculture, skills development, and food supplementation. In cooperation with CBATDS, CBERS is providing daily food rations to all refugees living in the two largest holding centers for Kampucheans in Thailand with produce bought directly from small Thai farmers. At present CBERS is the largest private Thai agency providing refugee relief services in Thailand.

The Formation of CBATDS

When experience showed that family planning alone was not enough, CBFPS increasingly concerned itself with other problems directly affecting daily life including unemployment and low incomes. In an attempt to address some of these problems a number of small income generating projects were carried out on a small scale by local communities and CBFPS field staff and volunteers. More technical and financial assistance was required before anything could be done on a large scale. Hence, CBATDS was founded to fill the gap between local efforts at problem solving and the necessary technical and financial support needed.

The basic premise upon which CBATDS was formed is that the delivery system (what CBATDS calls "change agents") established for family planning could be utilized for "delivering" the knowledge and material input associated with household water supply and sanitation, livestock production, and other activities. (Bruns, 1981.) Family planning acceptors have been the main beneficiaries of these new programming initiatives, receiving priority inputs and preferential credit rates.

Now in its fourth year, CBATDS has received grants totalling approximately US $4,000,000 for implementation of field projects through 1983. These include the second phase of the rainwater tank project and the Community Based Integrated Rural Development (CBIRD) project in Buriram Province, Northeastern Thailand. Additional projects involving somewhere in the neighborhood of US $3,500,000 in grant monies are currently pending. With its staff of over 90, including administrators, field supervisors, clerical staff, and technicians, CBATDS is a large scale operation in comparison with most other non-governmental organizations in Thailand and other developing countries.

The creation of CBATDS was both a response to increasing perceived demands for more comprehensive development programing at the village level and an opportunity for PDA to diversify and expand its funding base. Various reasons have been given for this expansion. Critics of the organization question such rapid growth and are wary of linking family planning and development programs.

CBATDS's Goals

According to its own statement of purpose (CBATDS Annual Report), CBATDS "seeks maximization of the common people's participation in the development process as its strategic

objective, hence the term 'community-based.'" CBATDS's "end product" is "the enhancement of the quality of life." "In the development process," the statement continues, "CBATDS aims to promote low cost, ecologically sound appropriate technologies that are compatible with rural Thai social, cultural, and economic conditions," and "to introduce change gently on a small scale, and to create trust, credibility and tangible benefits to individuals and communities." Its longer term goals are "to strengthen ... local and regional groups in conducting appropriate technology dissemination services," "to assist Thai government efforts in promoting integrated rural development," and "to assist Thai government and international aid agencies in determining the minimum input requirements for promotion of village-level technologies."

CBATDS's Geographic Focus

CBATDS's activities to date have been concentrated in four provinces of Northeastern Thailand (Khon Kaen, Surin, Mahasarakham, and Buriram) and one province of Northern Thailand (Chiang Rai). Additional provinces in Northeastern Thailand, including Nakhon Ratchasima, Sisaket, and Ubon Ratchathani, will soon be added. Concentrated projects involving rainwater catchment and storage technologies were initiated in Khon Kaen and Mahasarakham provinces and are projected to expand to Buriram province, all in Northeastern Thailand.

Northeastern Thailand presents rather formidable development challenges, including a fragile drought-prone semi-arid agricultural base, a disproportionately large population, the highest incidence of poverty in the kingdom, and the political instability related to being a frontline border region facing Laos and Kampuchia. A regional profile of Northeastern Thailand appears here as Table 1.

CBATDS's Approach

CBATDS claims to act as a catalyst to mobilize rural villagers into self-help projects and mutual assistance groups to upgrade their living conditions and to create employment and income opportunities. While CBATDS often takes the initiatives, it attempts to minimize the disruptive potential of rural development interventions and recognizes the complex social and economic systems of the village environment. Accordingly, CBATDS utilizes local officials, technicians, and laborers during project implementation while simultaneously attempting to strengthen village links with government officials, who are encouraged to participate in

Table 1

PROFILE OF NORTHEASTERN THAILAND

Number of provinces	16
Total population	15,792,825
Area (km^2)	185,156
Population density (persons/km^2)	85.3
Average annual rainfall (mm)	1,250
Average annual days of rainfall	95
Average farm size (hectares)	4
Average farm household income (baht)	10,280
Average family size (persons)	7

This chart is taken from the February 1982 CBATDS's Proposal for Rain Water Collection and Storage Project (Tungnam II).

project activities. According to CBATDS, villagers are encouraged to play an integral role in all phases of the small-scale projects -- in design, construction, maintenance, and financing. As in the PDA's family planning program, CBATDS propagates and promulgates its projects through creative self-financing schemes, which combine cooperation and ownership. Therefore, it is hoped that villagers are instilled with a sense of confidence and pride in their own capabilities.

The initial entry point into communities in all cases of CBATDS development activities was through the family planning campaigns, although the propaganda stunts devised by Khun Meechai to promote family planning (such as passing out condoms to drivers stalled in Bangkok's notorious traffic jams) are not a part of the water-tank construction project. Local family planning volunteers, who act as CBATDS's main contacts for local development activities, are often influential and informed people in their communities. These are traders, farmers, shopkeepers, ricemill operators, silk producers, village council members, etc., who have a personal and collective stake in village self-improvement and economic advancement.

CBATDS's Decision-Making Process

CBATDS, by virtue of its relationship with PDA, has inherited a decision-making process which combines centralized planning and management in Bangkok with local structures for problem identification and program implementation. Allocation of funds and other resources and staff selection invariably take place at headquarters, in response to information feedback and requests from the field. Similarly, headquarters sees that the field activities of local volunteers and technicians are monitored closely. CBATDS represents itself in proposals and reports as a more decentralized organization that it actually appears to be. The continuation of centralized decision-making authority in Khun Meechai and his immediate subordinates apparently has its analogs in traditional and contemporary Thai society. This stress on "charismatic entrepreneurship" explains much of the success at raising funds and gaining influence achieved by the organization.

CBATDS's Activities

In its first annual report (1981), CBATDS reported that outside of the water-tank construction project (described in the next chapter), its major activity was an alternative marketing program (the Small Farmer Fair Price Marketing Program) designed to address the major problem facing rural farmers: lack of reliable markets. Participating farmers

are entitled to government guaranteed prices (substantially higher than middlemen's prices) for their farm produce. CBATDS then markets this produce to organizations providing food relief to refugees in Thailand and to tourist hotels in Bangkok. Plans are to extend the market to hospitals, schools, labor unions, and factories in the greater Bangkok area. In its first year, the Fair Price Program marketed over 5,000 tons of farm produce.

CBATDS is also assisting farmers by making financial resources available to them in the form of credit for construction materials, livestock, seeds, animal feeds and fertilizers. CBATDS has helped to mobilize village development committees for loan repayment and recycling and is providing capital for village cooperatives.

In the technical field, CBATDS conducts feasibility studies, field tests and cost benefit analyses of various appropriate technologies related to the supply of safe drinking water, sanitary disposal of waste, and biogas generation. Technical assistance is provided to village groups in farm management, water and sanitation resources development, biogas, and cottage industries promotion. A network of regional Village Appropriate Technology Training Centers and Integrated Demonstration Farms is being developed for on-farm skills training and agricultural extension services.

II

THE PROJECT

Problem Identification

The origin of the CBATDS Rainwater Collection and Storage Project in Northeastern Thailand can be traced to the formative discussions, consultations, and brainstorming sessions held in Bangkok during 1979. The key decision maker, Meechai Viravaidya, secretary general and chief conceptualizer for PDA, and Dr. Malee Sundhagul, then director-designee of CBATDS, used consultants for feasibility analyses and program priority deliberations but primarily drew upon their extensive technical and development planning expertise. Khun Meechai is a prominent, unconventional and controversial development economist, and Dr. Malee is a highly respected microbiologist, a dynamic program co-ordinator with solid scientific credentials. After determining that the Northeast should be the priority area for development activities, and incorporating the inputs of other expert advisors, Dr. Malee and Khun Meechai selected water supply and sanitation as a priority emphasis. This was a carefully made but still a priori decision on the part of these administrators. Besides the obvious need from a public health point of view, water supply and sanitation seemed to be a promising entry point for field research, development, and dissemination for the newly formed CBATDS.

The Survey

In January 1980 Dr. Sam Johnson of Ford Foundation became involved in program support discussions in Bangkok. Ford's interest in PDA and CBATDS had been spurred on by a combination of familiarity with PDA's promise, professional relationships, and the formation of CBATDS with flexible support from ATI. Doctors Malee and Johnson held extensive consultations on their mutual interest in establishing a program to develop a field technology adaptation and dissemination methodology, and water supply in particular attracted priority attention. A specific program for a pilot field experimentation scheme was designed and Ford awarded CBATDS a $200,000 grant to implement it.

PDA/CBATDS field staff and technical volunteers stepped in to give the program shape, direction, and momentum. CBATDS district supervisors and family planning volunteers are a known quantity in several Northeast Thailand provinces, and their legitimacy and presence had been established for several years in rural communities. Formal and informal consultations with local government officials, farmers, and government extension workers from the ministries of health and agriculture ensued in early 1980 and were followed by the design of a rudimentary and practical water resources survey format. CBPFS volunteers and supervisors were utilized by CBATDS's still small staff for information gathering and needs and demand assessments regarding water supply. The survey was intended to be a representative sampling which would assist in prioritizing follow-on research and development. In CBATDS's own words: "Organizational constraints to the widespread dissemination of water and sanitation-related technologies were identified and overcome through CBATDS operations research in the Northeast. Water assessment methodologies and a system of 'water shortage priority' ratings have been developed and are being replicated on a wider scale. These guidelines are being used for planning and implementation of a comprehensive water resources development program in three key districts of the Northeast." (Anderson and McKeon, 1981.)

The survey identified technology issues and developed a short list of potential technical responses to the severe draught conditions facing people, crops, and livestock in the Northeast. From the standpoint of availability, quality, capital costs, maintenance and operation, and convenience, the options arose as follows: surface water catchments, piped water, wells (with or without pumps and casements), rainwater collection and storage, and small-scale water treatment. One of the key CBATDS technical volunteers, Brian Bruns of the Peace Corps, carried out a detailed socio-economic and cost-benefit analysis of these options (Bruns 1981). Bruns reports that the following responses were most often elicited from villagers:

* drinking water had a higher priority than water for other uses, due to the saline conditions of groundwater;

* health consideration, i.e., means of reducing pathogens via boiling, filtration, treatment, etc., were not mentioned as a priority concern;

* rainwater collection where feasible and adequate in quantity was an attractive alternate to the ubiquitous open pond catchments for many villagers;

* sophisticated, high capital cost, or community-scale systems held little attraction and were not likely to succeed unless sizeable subsidies were made available; and

* villagers required technical, logistical, and financial support to reduce the risks and generate adequate incentives for a water supply program to make any inroads into rural communities.

These findings are compatible with the conclusions of Ken Darrow in the Appropriate Technology Sourcebook and Gus Tillman in Ecologically-Sound Techniques for Small-Scale Water Projects. According to Darrow and Tillman, projects attempting to utilize appropriate technologies and development techniques for the promotion of small-scale water supply should make optimal use of locally available material and human resources (including traditional technologies), be based on community-identified and/or commonly realized needs, be compatible with available funding, have the potential for being maintained and monitored by community members and completed in a reasonable time frame.

While the surveys were being performed CBATDS began the pilot prototype activities. Normally such activities would not be undertaken until the survey was complete; however, in the case of CBATDS, the surveyor-facilitators had an established, credible presence in the communities they entered and flexible logistical and material support with clear guidance from headquarters was forthcoming. Another factor mentioned often by CBATDS staff and local participants was that the presence of outside catalysts, at first primarily foreign volunteers, provided added perspective and momentum to this project.

The choice of the particular technologies -- bamboo reinforced concrete tanks and wire-reinforced water jars -- by a sizeable and growing number of villagers appeared to be in response to the pilot introduction scheme in Ban Pai subdistrict of Khon Kaen Province and scattered villages in Mahasarakham Province. Villagers were impressed by the convenience, construction methods, and financing scheme used in that project. During village discussion and survey

sessions, rainwater tanks or jars spontaneously arose as a viable option for many participants. Demand, acceptance, and availability apparently merged throughout the crucial period from mid-1980 through mid-1981 when the effort picked up momentum as information and experience related to the implementation of these village-based catchment systems spread within and between villages in the target areas.

The rainfall regime and ground and surface water conditions in the villages where tanks have been successfully implemented are remarkably similar, thus contributing to a successful fit and effectiveness between the technology and its users' requirements. Annual averages for the region of 1,365 millimeters are rarely achieved in these areas, and rainfall is concentrated in infrequent torrential rains, thunderstorms, and cyclonic disturbances during the rainy season which generally lasts from May to September. Minimal amounts fall during the seven month dry season, thus placing severe stress on human, animal, and plant populations. Donner's summary of environmental conditions of the Northeast concludes, "the natural state of the region is full of disadvantages and, though it is possible to survive, the achievement of rapid progress towards general well-being of the population requires substantial investments with emphasis on water control and soil fertility." (Donner 1982.) Villagers generally obtain drinking water from open catchments on vacant or community land if it is not overly muddy, turbulent, or loaded with organic matter. Also rainwater is collected and stored or water is purchased and brought back home from towns or cities where commercial sources are available. The water table in most of the areas visited varies from six to fifteen feet, but the water is generally judged too saline for human consumption.

Dissemination Strategy

CBATDS's dissemination strategy and the concepts upon which it is based are best explained by quoting from CBATDS's documents (CBATDS's Annual Report, 1981). When the specific technology has been determined by field staff and ratified by Bangkok administrators,

> CBATDS builds upon the social mobilization strategy of the CBFPS, which is based on the assumption that communities are capable of perceiving and solving their own development problems, given adequate guidance and motivation. It includes the transfer of

> authority for local program planning, operation, and day-to-day evaluation at the community level. Such community oriented programs tend to avoid the cultural insensitivities and communication failures plaguing the delivery systems.
>
> CBATDS views marketing as a critical component of its efforts to disseminate appropriate technologies throughout Thailand. The surplus generated from marketing activities increases the economic base of ongoing programs and of farmers. We do not look upon "appropriate technology" as an isolated component of economic development. Our aim is to encourage local people to recognize their innate ability to provide for their own betterment. We provide technical and financial assistance, but ultimately it is the people themselves who create development. Investing their labor, their savings and their local resources will bring self-sustaining prosperity over time. It is this very positive and integrative view of development which our programs hope to incorporate into the economic and value system of the Thai people.

CBATDS's dissemination strategy for its rainwater tanks project stresses an optimum combination of cooperative work, soft loans (revolving credit fund), and logistical and technical assistance. A view of how this process took shape in Northeastern Thailand follows.

The Pilot Project

The village of Ban Lan, Ban Phai District, Khon Kaen Province, where the first tanks were built, presents an instructive account of the technology adaption and dissemination process. In the course of discussing water supply problems during the water resources survey, ex-CUSO (Canadian) volunteer engineer Paul Grover, who is fluent in Thai, built up a friendship with a group of local farmers and craftsmen. The group included members of the village council, other influential members of the village, and two men with experience in construction. One of these was a young mechanic

who became a focal point of a discussion group which was formed after the meeting with CBATDS's staff. Ban Lan is a primarily agricultural village of 300 families located on a paved road linking Ban Phai with Mahasarakham. The electrical grid was just extended to this village in 1978, and it could be considered low to moderate income relative to the rest of the surrounding area. Animal traction for agriculture, charcoal as a cooking fuel, and traditional raised wooden houses with tin roofs predominate in Ban Lan.

The discussion group held several meetings which led to a determination by twenty members to commit themselves to building bamboo-reinforced concrete tanks, which CBATDS pledged to finance on a cost-recoverable basis. The original group dwindled to six families who organized themselves loosely into a work group. The design used was based on one developed by the Sanitation Department of the Ministry of Health, which lends out the steel forms needed to make the tanks to groups and individuals interested in self-help. Villagers had examples of both functioning and non-functioning rainwater tanks available at schools in surrounding villages.

Twelve tanks were constructed in a second effort four months later, fifteen in a further installment in late 1981, and preparations for a more massive construction program of thirty tanks at one time were underway when this report was being prepared. Several other enterprises arose as a consequence of CBATDS-sponsored activity in Ban Lan Village. Two experimental biogas plants were constructed in late 1980, but no momentum towards further dissemination has become evident. Additionally, CBATDS procured low-interest private loans to enable the young mechanic, at whose house the first tank was built, to establish a metal fabrication shop. This workshop is now self-supporting and produces metal cement mixing forms (among other things) for CBATDS field operations. Since the original fifty-one tanks were built in seven villages in a span of six months in late 1980 and early 1981, the project has been institutionalized as a special unit within CBATDS.

CBATDS staff and the local construction crew went through this first experience in October 1980 directly in a trial and error fashion. They decided to pour all six tanks in stages of two ring forms per tank until each tank was finished. This meant that the work was stretched out over fourteen days, and that many forms were required. Building material was not always available, and not all families met their daily work obligation. Nevertheless, all six tanks were built, proudly

emblazoned with ceremonial insignia, and finished in preparation for the upcoming rains. Ultimately, all six tanks performed their tasks of collecting and storing rainwater with only minor difficulties (some faucets had to be replaced, one tank had to be replastered due to poor quality concrete). The finished tanks, ranging in size from 6 to 11.3 cubic meters, served as a strong stimulant to generate demand, instill confidence in prospective users, and increase community pride.

Successively, as interest rose, CBATDS supported further tank construction with its loan funds, an increasingly capable work force evolved (dubbed "technicians" by Bangkok staff), and a more streamlined and selective promotional system developed. Construction practices and tank size became standardized, designation of participants became less ad hoc, and participation was assured through incentives (lower costs to users and fines assessed to families who failed to contribute labor). CBATDS staff began going through formal local governmental channels to obtain endorsements for construction efforts. Work crews were taught scrupulously to measure the amounts of sand, stones, and other material brought to worksites to ensure honesty. This proved to be difficult, since open confrontations are anathema to many Thais. (Table 2 summarizes the method CBATDS uses in disseminating this technology.)

This developed infrastructure now includes three small trucks for transporting formwork, cement, and other supplies from one building site to another. Revolving loan fund collection, storage, disbursement, and accounting is also based in the field offices.

Tungnam I

The project initiated in Ban Phai District has been repeated in over 70 villages in eight subdistricts of Khon Kaen and Mahasarakham Provinces. A grant from Agroaction of West Germany for $350,000 (฿7 million) for the construction of 1,000 tanks was initiated in May, 1981. The project was called Tungnam I (tungnam means "water tank"). In early March 1982, two months ahead of schedule, the 1,000 planned-for tanks had been constructed (see Table 3) and Agroaction was preparing to fund a follow-up funding program, Tungnam II, totalling approximately US $1,080,000 (฿20 million) earmarked for the construction of 2,500 to 4,300 water tanks in the course of two years, from June 1982 to June 1984.

Table 2

CHART SUMMARIZING SOFTWARE ASPECTS OF CBATDS's TECHNOLOGY TRANSFER

I. Project Preparation	II. Entering the Village	III. Implementation	IV. Follow-Up
Inform provincial government officials about project and seek permission for implementation. CBATDS initial survey of village domestic water resources/community leaders identified for village committee. Contact district public health officials-explain project and seek cooperation. District health officials and CBATDS work together locating suitable villages. Appropriate indigenous materials are located (i.e., bamboo, banana stalks). CBATDS hires technicians, clerical staff and acquires office space/purchases tools and construction forms.	CBATDS staff meets with village health workers, family planning volunteers, and headman to explain project. CBATDS staff, health worker, headman, and family planning volunteer work together locating interested villagers. A meeting is held among interested villagers. Policy is determined. Village technicians are located and invited to a training session about rainwater tank construction. A village committee is established to help oversee construction activities, insure village cooperation, and assist with distribution of contracts.	Metal forms and construction tools are moved into the village. Supply shops are contacted and materials ordered with the assistance of the village committee. Formation of construction teams from individual households. Preparation of ground and bamboo. Construction of tanks.	Postcards are left with tank owners (any difficulties with the tanks can be reported easily to CBATDS). Necessary repairs are made. Continued motivation through the village committee. Continued construction through sponsorship program. Monitoring and evaluation.

This chart is taken from Introducing Hardware Technology with a Soft Touch, by Ed Anderson and Bob McKeon (mimeographed), August 25, 1981.

Table 3

TUNGNAM I

TANK CONSTRUCTION BY MONTH

Month	Number of Tanks
1981:	
May	5
June	62
July	60
August	92
September	117
October	170
November	54
December	136
1982:	
January	47
February	120
March	141
TOTAL:	1,004

A.T. International Support

CBATDS has received increasingly larger amounts of external assistance since its inception in December 1978, consonant with its expanded scope of activities and growing capacity to absorb larger amounts of funding and technical assistance. The program began with a core staff of three initiating promotional activities in two districts. In slightly over three years it encompassed over ninety staff members located in nineteen districts of Northern and Northeastern Thailand. Meechai Viravaidja attributes a great deal of the growth and development of CBATDS to the flexible and timely support of ATI in providing early assistance for program development and the pilot project.

CBATDS's initial program support was a planning grant for $25,700 awarded in August 1979 by ATI. This grant, which provided eighteen person-months of consultant time, core staff salaries, and lesser material costs for one year, enabled PDA to set up CBATDS as a full-scale appropriate technology service bureau. The bureau eventually conducted comprehensive planning and pilot experimentation exercises and drafted a work-plan for priority districts of the country.

The final report of the planning grant provided the basis for a follow-on funding package for the expansion of field implementation activities, totalling $479,965 over thirty months. Included in this three phase scheme (planning and preparation; research, development, and widescale dissemination; and follow-up and expansion) are core staff support, materials and equipment, and a preliminary revolving loan fund. Major donors were A.T. International ($203,365), the Ford Foundation ($210,000), PDA itself ($35,000), International Development Research Center (IDRC) ($14,000), CUSO ($10,000), and the Canadian Embassy ($8,600). The three major areas of emphasis were water resource development and sanitation, agricultural extension and marketing, and cottage industries development. ATI's grant funds were used to support the institutional development component, while the other donors contributed to specific activities.

ATI also supported CBATDS in a program to provide technical inputs to the government's Dry Seasons Public Works Program with a grant of $25,840. This project was intended to develop and implement a prototype cooperative venture between an indigenous non-governmental organization and the Thai government. The project had CBATDS organizing village groups to work on community water supply, sanitation, and irrigation projects similar to CBATDS's own ongoing projects. Although results have been modest to date, in comparison with the rainwater tank project

this experience has helped PDA and CBATDS attract the attention of various national, bilateral, and multilateral development agencies. Along with Development Alternatives International, a U.S. consulting firm, and another Thai firm, PDA was awarded a contract recently to provide management assistance to the Thai government as part of a US $3 million, four-year program financed by the U.S. Agency for International Development.

ATI's funding support served to strengthen CBATDS's ability to implement field programming, thereby attracting the attention of various other donor agencies. Funds several times in excess of the amount granted by ATI have been leveraged from other international donors and the Thai government. While ATI did not play a direct role in CBATDS's contacts with other donors, its critical catalytic support was the major reason the organization was able successfully to market its services elsewhere.

ATI has been a neutral catalyst, intervening only occasionally but never trying to control the evolution of the actual program. ATI did hold extensive programming discussions with PDA in the formulation and monitoring of CBATDS's activities, and ATI staff, particularly both the former and the current director of the Asia/Middle East team, have contributed occasional technical assistance to CBATDS and PDA staff. Additionally, ATI has sought to expand the programming collaboration into a larger partnership with its other associates in Asia by inviting PDA/CBATDS participation in the Asian Alliance of Appropriate Technology Practitioners (Approtech Asia). Approtech held its charter meeting in Bangkok under the auspices of PDA in May 1980.

Although the ATI-CBATDS collaboration can be said to be productive, as witnessed by the field survey of the rainwater tank project, there are special problems. Due to the complex and ambitious nature of CBATDS's programming, it has been difficult to monitor funds and program plans for cause and effect assessment. Both donor institutions and field staff have had difficulties in coping with the accelerated pace of proposal generation and program expansion in Bangkok at headquarters. Relative to other Thai development organizations, PDA's growth, as a result of massive foreign assistance, has been rather dramatic. Also, ATI's supposition that it would be perceived as "different" from other donors or "unique" were idealized and unrealistic.

Table 4

CBATDS's PROJECTS APPROVED FOR IMPLEMENTATION AS OF OCTOBER 1981

TITLE	FUNDING AGENCY & FUNDS	COOPERATING AGENCY	IMPLEMENTATION DATES	MAJOR ACTIVITIES
Rainwater Storage Tank Construction	Agroaction/Germany $350,000	Khon Kaen Regional Sanitation Center	April 1981 to March 1982	• construction of 1,000 (11m^3) bamboo-reinforced cement water tanks with by-pass valves and water collection systems • training of 17 village water resource technicians
Agriculture, farm management, and health training program	Konrad Adenauer Stiftund/Germany	Kasetsart University faculty and consultants	June 1981 to July 1982	• training of 105 village volunteers and field staff in the areas of farm management, integrated farm systems, appropriate technology for village life, cooperative development, pesticide poison prevention and environmental sanitation
Community-Based Integrated Rural Development (CBIRD)	EEC and Agroaction $1,000,000	Khon Kaen Agriculture Center, Khon Kaen Medical Center, and Siriraj Hospital	September 1981 to May 1982	• better marketing services, resources and technical assistance in integrated farming, environmental improvements, home industries, cooperative development, health, nutrition and family planning for 60 target villages in two provinces reaching 2,750 households

TITLE	FUNDING AGENCY & FUNDS	COOPERATING AGENCY	IMPLEMENTATION DATES	MAJOR ACTIVITIES
Water resources development and management	Ford Foundation (pending final approval)	Global Project (World Bank) technical consultants and planning assistance	January 1982 to December 1983	• construction of village reservoirs, ponds and other appropriate water catchment areas, irrigation systems, spill dams, water lifting technologies
Using winged-bean to provide food for refugees and improved nutrition and income for Thai farmers	PDA Thailand Institute of Science and Technology Research (TISTR) International Council for Development of Underutilized Plants	CBERS/PDA TISTR	July 1981 to June 1983	• training for 12,000 Khmer refugee families and 6,000 Thai farmers in winged-bean cultivation and processing to produce edible oils, weaning foods, and residual animal feeds • supply of seeds, seedlings, and processing equipment • contract growing arrangements with farmers whereby prices are guaranteed for all wing-beans produced
Promotion of energy-efficient stoves and alternative fuels for refugee camps	UNHCR $25,000	CBERS/CBATDS VITA	June 1981 to May 1982	• 60 prototype fuel and efficient stoves developed and tested • Khmer refugee training program for construction of stoves from local materials • construction and distribution of 7,000 stoves (deferred)
		CBERS/CBATDS	September 1981 onwards	• supply of rice husks, corn cobs, and other alternative fuels to camps

Support of Other Organizations

CBATDS has called on external technical assistance in the form of expert consultants and foreign volunteers (from CUSO and the Peace Corps) to suit its institutional capacity-building requirements. These individuals, particularly the technical volunteers working in water supply and sanitation on agricultural projects, have been given substantial responsibilities, but minimal authority, except in special cases. Various Thai scientific and technical institutions have been tapped for design and planning assistance, including the Thailand Institute for Science & Technology, various regional universities, and government extension services.

CBATDS experienced exponential growth in 1980. As the pilot introduction phases neared completion, two large grants were secured from foreign donors for an extension of Tungnam I: US$ 350,000 from Agroaction of West Germany and a large operational grant (US $1,000,000) for a comprehensive development scheme to be located in Buriram Province in Northeast Thailand for CBIRD (the Community Based Integrated Rural Development Project) jointly financed by the European Economic Commission (EEC) and Agroaction. Table 4 is a list of CBATDS projects approved for implementation by October 1981, with approximate dollar figures (where known). This list includes projects jointly conducted with CBATDS's sister agency CBERS (Community Based Emergency Relief Services). (Complex funding and programming arrangements appear to be a PDA trademark.)

Not included in the table are a large contract which was obtained by CBATDS during the field survey period and a follow on phase for the construction of 2,500 to 4,300 additional rainwater tanks (approximately US $1,090,000 from Agroaction). The majority of funds (averaging 60% of the total amount) in each of these recent projects is allocated for a block grant for project implementation which is converted by CBATDS into a revolving loan fund to project beneficiaries. Thereby the potential for recirculation of funds and a multiplier effect beyond the original amount is incorporated into the projects. The remaining amount of each contract encompasses CBATDS overhead in the form of field staff, logistical, material, Bangkok-based managerial, and extraneous expenses.

III

THE TECHNOLOGY

Basic Description

CBATDS adapted and improved designs and construction practices for rainwater cisterns previously existing in Northeastern Thailand. These collection and storage vessels are primarily of two types: large volune (6 to 11.3 cubic meter capacity) bamboo-reinforced concrete cylindrical tanks and wire-reinforced thin-membraned concrete semi-spherical jars (1.4 to 2 cubic meter capacity). These are intermediate modified technologies, combining traditional and conventional (modern) construction methods. During the remainder of this report, reference will be made primarily to the large volume tanks, since they are at this time the more prevalent and popular of the two options. They are not currently commercially available whereas the jars are. (Over 1,000 tanks and approximately 50 jars had been installed by April 1, 1982.)

The two exhibit similar characteristics. They both use cast-in-place construction with portable shuttering (formwork) and are easily installed by inexperienced labor (assisted by local skilled technicians) in a relatively short period of time. The containers are compatible spacially, culturally, and functionally with most existing rural Thai homes, which generally have corrugated galvanized iron roofs with some form of rainwater collection via gutters and drains for one or more roofslopes. Portable reusable forms make for ease of construction.

The large volume rainwater tanks were designed in the early 1970s by the Department of Sanitation of the Ministry of Health in collaboration with the engineering faculty of Khon Kaen University. The bamboo reinforcement, a mesh of woven untreated seasoned longitudinally split culms, acts to increase the tensile strength of the concrete and reduce the hoop and bending stress on the base and wall of these cylindrical structures. After a square base concrete footing has been poured, round metal slip forms 1.5 or 2 meters in diameter are stacked up (leaving 10 cm for wall thickness) over the bamboo mesh and poured with a

standard 1:2:3 concrete mixture. The lid is later poured with sections of sheet metal and wooden props inserted as formwork, and inlet pipes and a manhole for cleaning and sealing the internal walls are installed. Complete instructions (in English) and illustrations (with Thai text) describing site planning, materials required, and construction techniques have been prepared by UNICEF. (The drawings that appear here come from these materials.) CBATDS staff essentially utilized this design and made some minor but significant modifications in the construction technique:

* An improved bypass valve, using PVC plastic plumbing parts with removable cleanout plug, was installed between the gutter and the water inlet into the tank to flush out dirt, debris, and animal droppings at the onset of the rainy season or after a long period without rain.

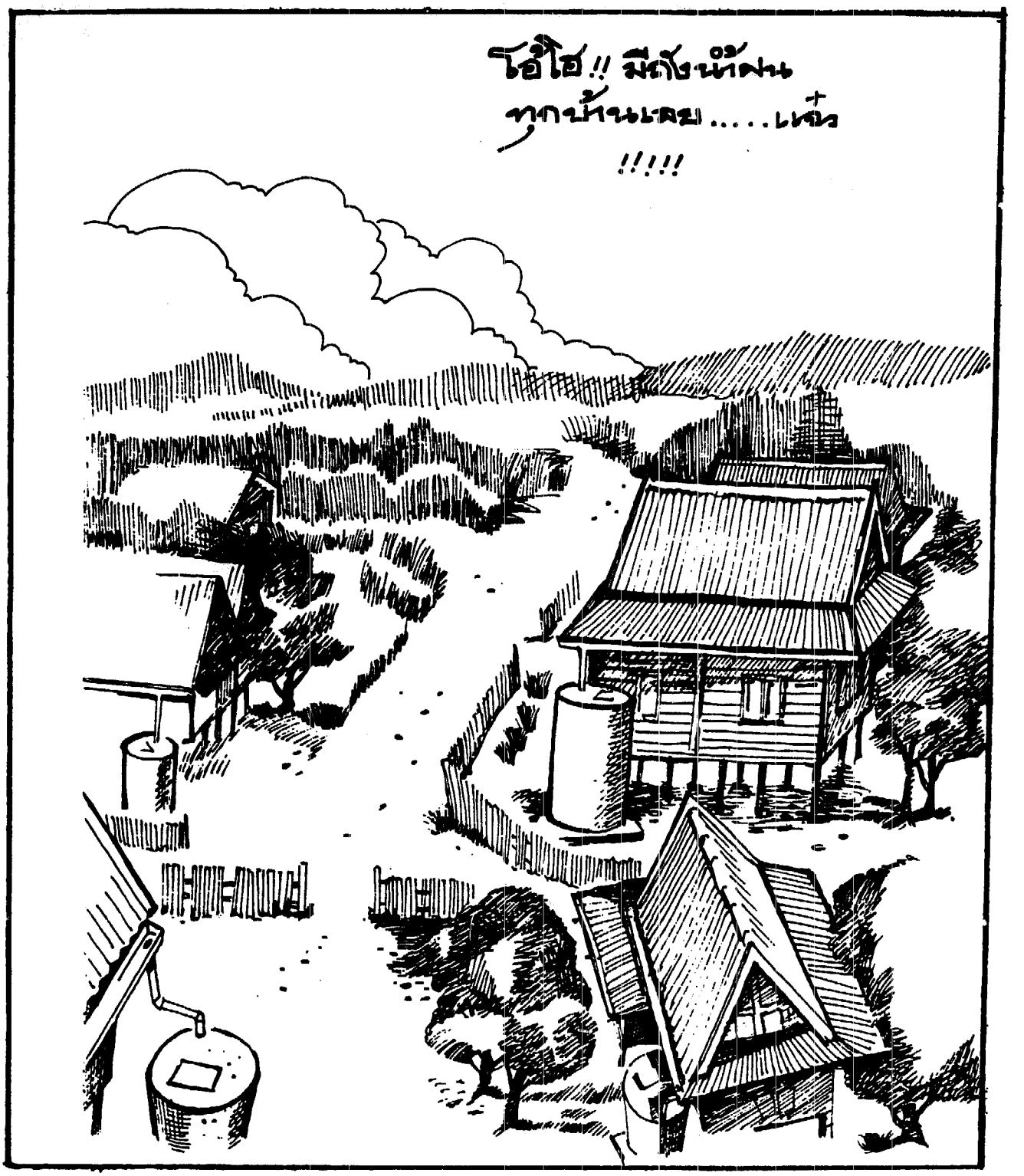
* After it was found to be inadequate, the supply valve at the base of the tank was reinforced by a concrete encasement. Also, because early experiences with washerless locking faucets were unsatisfactory, a replacement faucet with an alternative lock mechanism was substituted to prevent both leaks and theft.

* During the pilot introduction project when approximately 50 tanks were constructed, it was determined that rather than pouring a number of tanks simultaneously in stages, the shell of an entire tank could be constructed in one day. This reduced the total number of forms required by CBATDS, made the work progress quicker, and kept the motivation and momentum of the village construction teams high.

* Metal boxes for mixing concrete were constructed by CBATDS staff to be reused many times, resulting in an average saving of one sack of cement per tank (of thirteen sacks total required).

Construction materials are delivered directly to the villages in bulk shipments from nearby suppliers (sand, large aggregate etc.) and from CBATDS's stockpiles (cement, plumbing parts, bamboo, formwork).

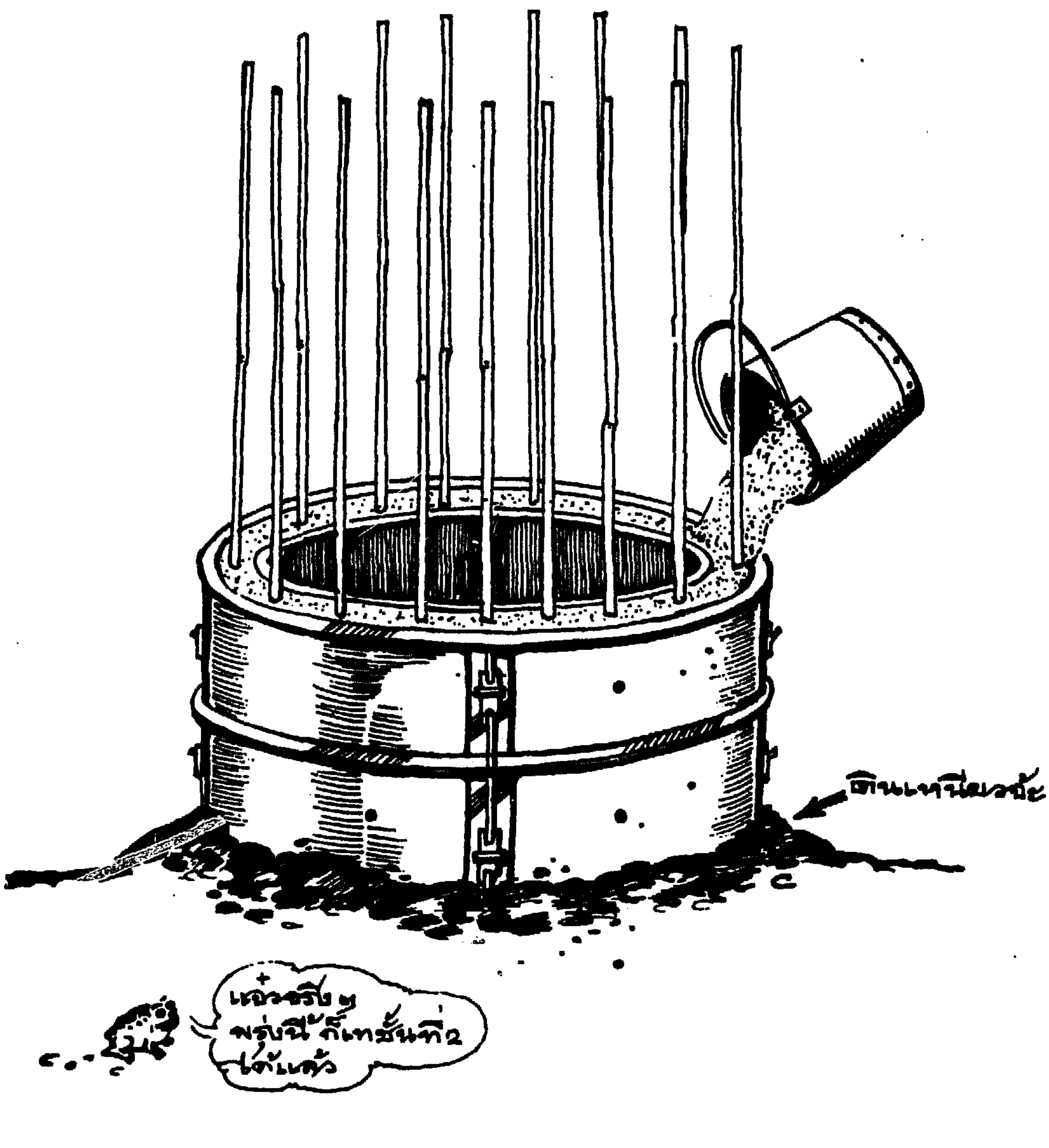
The wire-reinforced concrete water jars are modified from designs of existing jars (known locally as "big red jars" due to the protective paint coating they generally receive). These jars consist of a flat poured circular concrete base with curved ferro-cement walls and a flat lid and inlet. Construction usually requires only two to three workers (technicians and the owners) and can

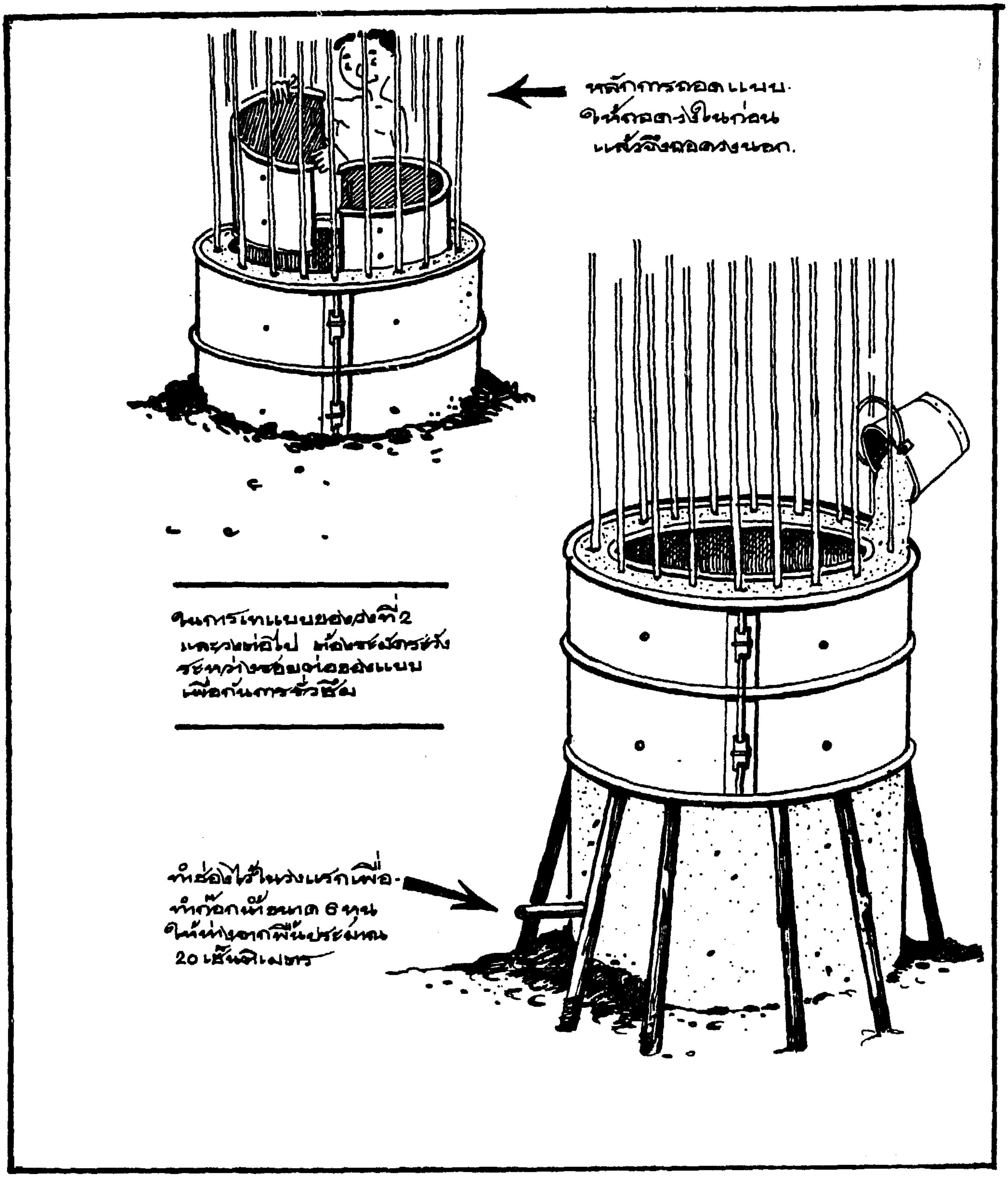


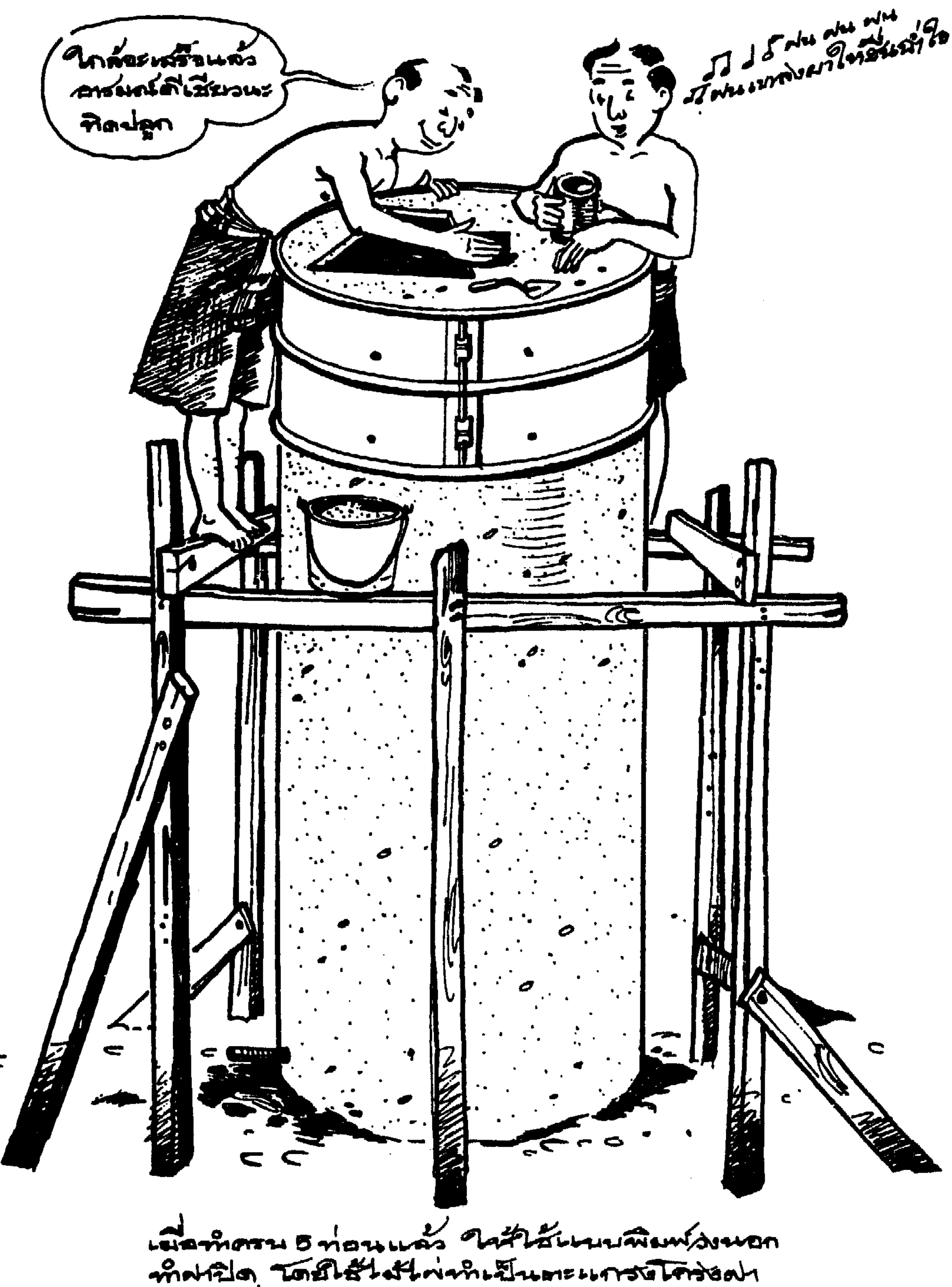
This illustration and those that follow are taken from a UNICEF publication providing complete instructions for constructing the bamboo-reinforced concrete water-tanks. Other illustrations, not included here, show what materials are needed and take the reader step by step through preparation of the foundation for the tank.


เห็นไหมล่ะ สร้างง่ายมาก
เก็บน้ำฝนไว้ใช้เยอะ
ลื่นไถลทั้งปี มีใครสนใจ
จะสร้างบ้าง ?
ยอดเลย ! ฉันตั้งใจ
สร้างสักถังหนึ่งละ
จะได้มีน้ำฝนไว้ดื่ม
นานๆ สบายไปเลย
ถ้ามีเงินต้อง
สร้างสัก 2 ถัง
ขอกินด้วยนะ
ดีจริงๆ
สงสัยสร้างกันทั้งหมู่บ้าน

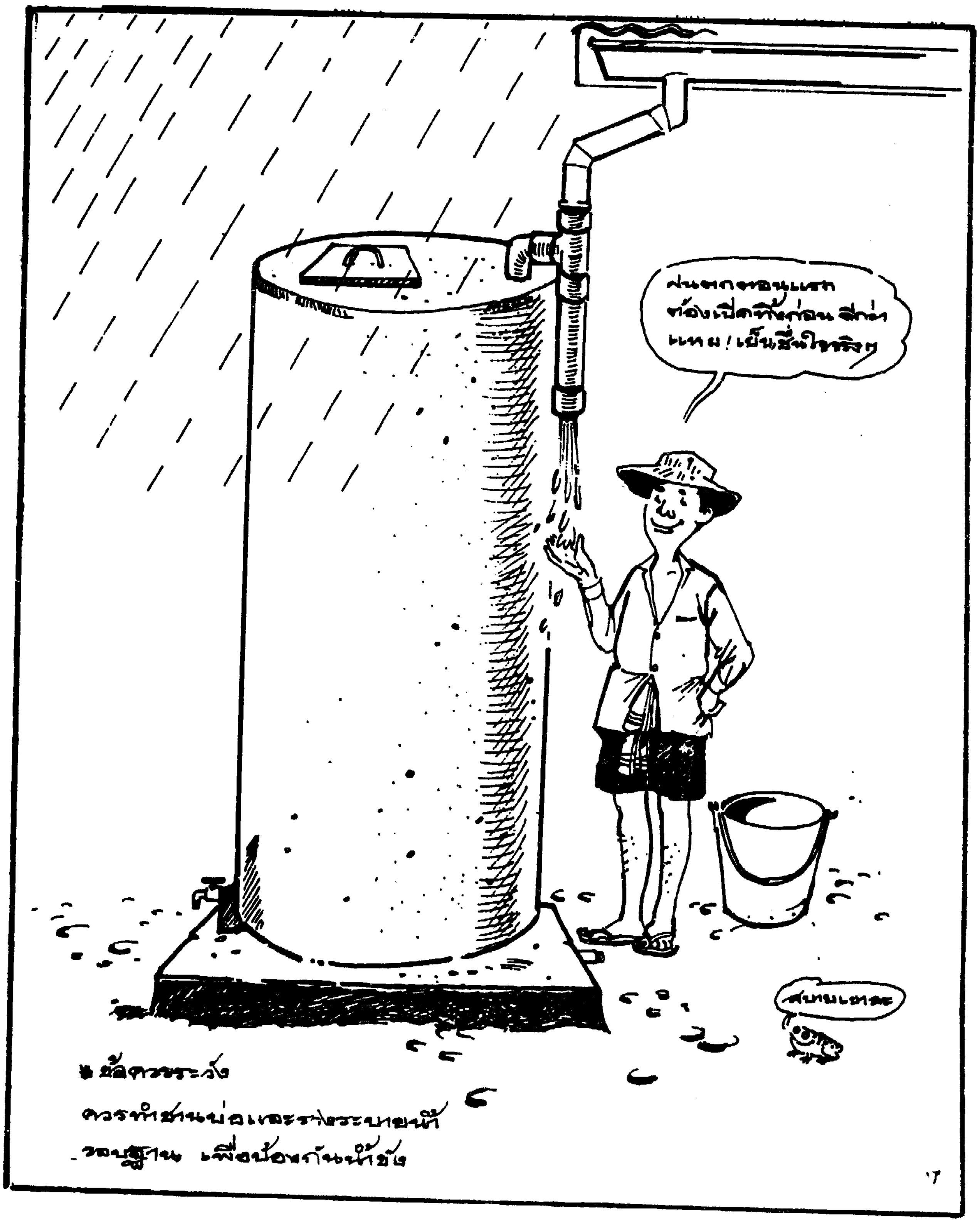
นำแบบพิมพ์ทั้งสองใบวงนอกทาน้ำมันเครื่องให้ทั่ว มาประกอบ-
กับโครงตั้งไม้ไผ่ จัดระดับให้อยู่ในระดับเดียวกัน แล้วเทคอนกรีต
อัตราส่วน 1:2:3 ระวังน้ำปูนไหลออกส่วนล่าง ให้ใช้ดินเหนียว
อุดก่อนเทคอนกรีต ทิ้งไว้ 1 วันจึงถอดแบบ.




หลักการถอดแบบ
ให้ถอดวงในก่อน
แล้วจึงถอดวงนอก.
ในการเทแบบของวงที่ 2
และวงต่อไป ต้องระมัดระวัง
ระหว่างรอยต่อของแบบ
เพื่อกันการรั่วซึม
ทำช่องไว้ในวงแรกเพื่อ-
ทำก๊อกน้ำขนาด 6 หุน
ให้ห่างจากพื้นประมาณ
20 เซ็นติเมตร



เมื่อทำครบ 5 ท่อนแล้ว ให้ใช้แบบพิมพ์วงนอก
ทำฝาปิด โดยใช้ไม้ไผ่ทำเป็นตะแกรงโครงฝา
และทำช่องคนลงขนาด 0.45X0.50 เมตร.
พร้อมกับใส่ท่อขนาด 3 นิ้ว ยาว 1 ฟุต เพื่อให้น้ำลง
แล้วใช้น้ำปูน (ซีเมนต์) แต่งฝาให้เรียบ ป้องกันรอยรั่ว.


ฝนตกตอนแรก
ต้องเปิดทิ้งก่อน ฮิกๆ
แหม! เย็นชื่นใจจริงๆ
สบายแฮะ
* ข้อควรระวัง
ควรทำฐานบ่อและรางระบายน้ำ
รอบฐาน เพื่อป้องกันน้ำขัง

be completed in two days. The construction is rather simple but requires more precision than the large tanks. Forms are constructed either of special curved fired bricks coated with clay or of metal slats wrapped with coir twine. CBATDS staff have recently built a number of the latter forms, thus reducing the time and expense of assembling and transporting bricks for every jar constructed. In the local factories where kilns and extra laborers are often located, the use of bricks is preferred. After the form is constructed, a coat of plaster is applied, reinforcing wire is wrapped around, and two external finish coats of plaster are applied. After the forms are removed, a finish coat is applied to the internal surfaces, and the lid, faucet, and inlet are constructed. While these jars don't hold much water (1.4 to 2 cubic meters), their per unit cost is quite low, and, placed in series, they may suffice for a family's drinking supply needs during the rainy season, given careful rationing.

Virtually all of the rainwater collection and storage systems surveyed in the field constructed within CBATDS's project were individual family installations. In the future, CBATDS intends to promote larger numbers of tanks in each village to approximate a community system. However, the demand and financial capabilities of individual villagers vary. The scale is decidedly not neutral, as differing sizes of tanks would require different construction techniques, equipment, financial inputs, and management systems.

(As part of the Dry Seasons Public Works Project CBATDS technicians assisted the local subdistrict governments in the construction of thirty-two public tanks at community facilities such as schools and health clinics. As is the experience with central government-financed community pumping station systems, public tanks often deteriorate due to poor construction and maintenance standards.)

Costs

Tables 5 and 6 show the relative costs of bamboo-reinforced concrete tanks. Figures in Table 5, the per unit cost of the tanks constructed with CBATDS assistance, were obtained by dividing the total budgets of the completed Tungnam I and the anticipated Tungnam II projects by the number of tanks installed. The total tanks constructed figure for Tungnam II is a projection by CBATDS staff and includes both tanks financed initially

Table 5

PER UNIT COSTS FOR THE BAMBOO REINFORCED CONCRETE TANKS

	No. of tanks constructed initially	No. of tanks constructed with revolving fund	Total tanks constructed	Total budget	Cost per unit
Tungnam I Project	1,000	--	1,000	$ 350,000*	$ 350
Tungnam II Project (Year 1)	1,000	(600)	1,600		
Tungnam II Project (Year 2)	1,500	(1,200)	2,700		
	2,500	(1,800)	4,300	$ 1,090,000	$ 253

Table 6

RELATIVE DELIVERED PRICE OF BAMBOO-REINFORCED CONCRETE TANKS

Government supported prices	฿ 8,000 - 11,000	US$ 393 - 480*
Contractors price (estimate)	7,000 - 8,000	306 - 350
PDA price (with overhead)	5,750 - 8,015	251 - 350
PDA price (to villagers)	4,000	175
PDA materials costs (actual)	3,500	153

* These figures are based on the devalued baht rate of $22.9 = US$ 1.

and by second and third recirculations of the revolving funds. Projections of the total number of tanks constructed with money allocated for the initial 1,000 vary from 3,000 (my conservative estimate) to 5,000 (Meechai's estimate) in ten years. At either extreme this would be an impressive multiplier effect.

The accuracy of such projections is contingent on a continuously high repayment rate. CBATDS reported a remarkable early rate in December 1981 at 101.1% of scheduled repayment. Initially, more credit-worthy individuals are selected to reduce repayment defaults in the initial construction series. Thereafter, more risky applicants are selected to participate in the schemes. After the third recycling of funds, CBATDS staff may elect to issue grants instead of loans.

Table 6 lists the relative delivery price to various parties for 11.3 cubic meter rainwater tanks. The government's figure (as reported by CBATDS and others) is extremely high because labor costs, contractors' charges, and extraneous expenses are added to the often already high cost of materials. When CBATDS has acted as a technical consultant to the Dry Seasons Public Works Program, the per unit costs are reduced to about ฿8,000 or about $350. An estimate was obtained from local contractors for installing tanks in villages, and the figures ฿7,000 to 8,000 (US $306 to 350) were given, depending on quantities installed and other logistical factors. This is almost identical to CBATDS's current per unit cost as extrapolated from Table 5 and much higher than the projections for the Tungnam II project costs per unit to users (for materials only). With respect to the 1.4 cubic meter wire-reinforced water jars, CBATDS cites materials cost at ฿375 (US$16), and price to users as ฿450 (US$20). Local factories which produce similar jars sell the jars for ฿550 to 600 ($20 to 22) and charge ฿50 to 100 for delivery to villages.

The most significant feature of both the tanks and jar dissemination schemes by CBATDS is that users are financing them by themselves. Nominal downpayments of ฿300 to 500 (US$13 to 22) and monthly installments of ฿100 to 200 (US$4 to 9) are required by CBATDS for prospective owner-builders of the large tanks. The opportunity costs have clearly been significantly lowered to potential users. Since there are virtually no tanks being constructed through individual self-help or contractor-assisted efforts, it is unlikely that people would have been able to get the tanks without the CBATDS project.

Cost comparisons between rainwater tank water supply and other sources, such as existing community treated water systems, are difficult and inappropriate. It might be more relevant to compare rainwater collected in these systems with water purchased and transported to villages on a predominately individual basis. This is also not a completely fair comparison, since the water is generally bought in small vessels (200 liter oil drums or smaller) and only purchased infrequently during periods of extreme shortages in the dry season. Villagers questioned said they paid ฿2 per barrel and ฿20 to 50 for transportation. This supplement would be obtained once or twice a month and used sparingly for drinking and/or cooking. Assuming a 6 liter person/day consumption rate, a family of five would be paying ฿1,200 to 2,700 per year to procure the same amount of water that the rainwater tanks collect annually at a minimum. Unlikely as this calculation is, it does indicate that rainwater tanks are very economical options for villagers who can afford the low total costs and repayment rates offered by the CBATDS project.

Design Tolerances

Perhaps the strongest characteristics of the project are the wide tolerances for accomodating variable conditions within the technology itself and its dissemination scheme. Tolerances for various critical factors are as follows:

Risk. Risk to users has been minimized because the technology has been proven in various villages throughout the region, the credit mechanism is well developed, and the implementing agency's capabilities are proven.

Error and precision. While not foolproof, the massive poured concrete construction techniques allow greater tolerances for error than with masonry or ferrocement construction. Improper curing of the poured concrete tank walls, observed during the field survey, does not necessarily damage the outcome as in more critical construction techniques. The thick walls and bamboo reinforcement reduce the potential for structural defects or load failure. This combination of factors reduces the requirement for constant supervision by skilled labor. Vigilance on the part of technicians and supervisors to measure the accuracy and quality of materials delivered by suppliers serves to reduce costs and improve the final results.

Timing. Proper timing of the construction crews so that the basic shell of each tank is constructed in one day, has led to sustained participation by all members through the

entire construction period of tanks per locality. To prevent absenteeism, a fine of ฿50 per day (the cost of hiring a laborer) was established for construction team members who fail to meet their work obligations. This measure has been very effective. Also CBATDS's ability to deliver the credit, logistical, and technical assistance in a timely fashion strengthens the resolve of individual families to participate and invest their scarce resources for rainwater tank construction.

Maintenance. CBATDS staff leave a self-addressed stamped envelope with owners to that they can ask for help in maintaining or repairing the completed tanks periodically. As long as the internal plastering and sealing of the tops is properly done, maintenance is a relatively insignificant factor. In the event of failures or leaks, the tanks can be repaired without insurmountable difficulties. It will require continuous monitoring to establish how well and how often follow-up maintenance is supplied by CBATDS.

Adaptation. Adaptation of the technology in terms of changing the basic design is limited. However, certain structural and water collection enhancements were incorporated into the final design, as previously described.

Utilization of Local Resources

As previously described the construction process involves moderately skilled workers trained as technicians directing a generally unskilled work-force consisting of members of the families of the subsequent owners. The owner-builders perform the rudimentary but important tasks of excavating, mixing, and pouring cement and filling. More skilled work is either performed directly by or under the supervision of the technicians. This division of labor and strong reliance on labor rather than specialized skills means that construction costs are kept down. It is a sensible arrangement, since highly skilled workmen are rarely available locally in Northeastern Thailand. Craftsmen with high levels of skill and training in rural areas are enticed to relocate to cities and even work abroad in the Middle East for construction contractors due to lack of opportunities in the villages.

Users replace the initial loan capital, which consists of material costs and a slight overhead, with their own funds. Their credit extended initially becomes a revolving loan fund which is recirculated for the construction of further tanks and related technologies. CBFPS volunteers, supervisors, or local CBATDS staff act as the bill collectors.

Anticipated Benefits

CBATDS anticipated that the primary benefits of the technology would be adequate drinking water for project beneficiaries, improved local environmental conditions, enhanced family health and productivity, and stimulus for broader cooperative village work projects and other local development activities.

"For drinking water," according to Bruns (1981), "the need is to develop and implement appropriate and feasible methods for providing safer drinking water which villagers will use." In the course of field interviews and observations I found that the large demand for the technologies (as expressed by the villagers' willingness to commit their own labor, time, and scarce financial resources) was generated by three salient features of the water tanks and jars: their convenience and effectiveness and the immediate return on investing in them. An important concern which CBATDS staff realized early in the course of the project is that regular access to adequate amounts of palatable -- rather than potable -- water is the primary concern of villagers in the semi-arid drought prone Northeast. Given the correct combination of stimulus and support for proven technology options by CBATDS, the key concern became managing rather than generating demand for the technologies.

The large bamboo reinforced tanks meet or exceed a family's annual drinking water requirements, if prevailing conservation consumption patterns are adhered to. The standard calculation for potential roof run-off is that 1 mm rainfall gives 1 liter/meter^2 of horizontal surface, or total run-off = R X A liters, where A = plan area of roof (M^2) and R = rainfall (mm). For an extremely low rainfall year (500 mm) and only one slope of a small 4 X 6 meter roof (24 square meters) annual projected yield would still amount to 12,000 liters or 12 cubic meters and thus fill the 11.3 cubic meter tank for the year. At a daily average minimum requirement of 6 liters per person (including cooking and drinking) a family of five could theoretically make this supply last for almost 400 days, or over one year. (Given that CBATDS gives almost exclusive preference for family planning acceptors in the designation of project participants, it is unlikely that the family using the collection tank would be that large.) Of course, such abnormally dry years are relatively rare, and most of the roofs where tanks had been installed had horizontal surfaces of between 30 and 60 square meters. An easy and cost effective means of doubling the water supply would be to connect the gutters of the other slope to the tank. This practice was rarely observed, thus indicating minimal need on the part of the users to do so.

The rationale users gave for investing their time, labor, and money in the technology rarely mentioned other factors besides water supply. The key factor in assessing the health benefits attributable to the existence of the new technology is that boiling water to purify it is an uncommon practice in the project area. Its purpose is not that well understood, and there is a shortage of firewood. Contamination is still possible with the rainwater tanks if the water is not properly handled after storage, and tests have not been conducted on the purity of water within the tanks. However, most references, and more important most observers, agree that the majority of pathogens are either eliminated or neutralized during storage if the tanks are properly maintained. Thus, health benefits probably do accrue to users of the technology.

At the time of the field survey, there appeared to be no correlation between latrine and water tank construction, and few owners were planning to connect these two systems. (Stored water would not generally be used in latrines.) The cost of latrines is low compared to the water tanks (฿125 to 1,250 given as common estimates, depending on the quality of materials used); however, the fact that few had purchased them indicated that there is not a strong felt need for them. Nonetheless, CBATDS staff was gearing up for a moderate promotional campaign to provide incentives to villagers by reducing the cost of borehole casings for the latrines by ฿20 per meter through local technician-assisted construction. Over 300 latrines had been constructed in the project area.

The existence of a methodology which stimulates cooperation among villagers, and the availability of technical and financial assistance may have a catalytic effect directly or indirectly on other promotional programs of CBATDS, such as biogas, agriculture, and cottage industry related livelihood programs, etc. However, no evidence exists as yet to substantiate these expectations.

IV

CONCLUSIONS

Review of Hypotheses

The field survey's findings in this case tended to corroborate many of the working hypotheses established by ATI's analysis unit prior to the exercise. These hypotheses were meant to provide guidelines for technology adaptation development projects, and they proved to be quite applicable in most cases in the CBATDS Rainwater Tank Project. A review of the hypotheses, with a corresponding discussion related to the project, follows.

1. Hypotheses concerning the nature of the indigenous sponsoring organization.

a. The degree of match between the organizations' technical capacities and the technical requirements of the technology relates positively to the success of its adoption. CBATDS procurred the requisite expertise and personnel in the planning, pilot prototype, and wider dissemination phases of this project. As stated earlier, the adaptation process initially involved a significant degree of external technical assistance in the form of consultants, government extension officers, and foreign technical volunteers. In the course of the pilot introduction program, the training of local technicians, village laborers, and auxillary project personnel effectively transferred the technical skills needed for successful site preparation, concrete production and pouring, plumbing, and finish work via actual implementation activities. At this time of the field survey, it appeared that CBATDS's field staff were no longer encountering technical problems related to completion and maintenance of the tanks. The primary foreseeable problems appeared to lie more in maintaining optimum standards and periodic follow-up consultations with users. A young civil engineer and a core of trained technicians form the technical backbone of the project.

b. The degree to which the organization involves the end-user community in the choice of technology and its adaptation is positively related to the success of its adoption. In this case, the end user community constituted the driving force behind the selection of the actual technology involved and the derivation of the dissemination scheme. CBATDS staff effectively assessed the obstacles local villagers face either in purchasing or constructing their own rainwater collection devices to meet their drinking water needs throughout the year. Initial trials determined that widespread demand for the technology among a broader segment of villagers could be generated if a package of credit, logistical, and organizational assistance could augment their "sweat equity." Participation of the users was elicited in the pilot project to establish a working consensus among CBATDS staff on how to proceed with the dissemination scheme, and thereafter became a key element in the group construction teams.

c. The degree to which the organization is able to draw upon external technical resources positively influences the success of the adoption. CBATDS staff have cultivated relationships with external technical resources, both domestic and international for specialized assistance. The basic designs and the initial research and development for the 11.3 cubic meter rainwater tanks originated with the Sanitation Division of the Department of Health. Occasional support as required is easily accessible from national universities, foreign volunteer organizations, etc., through PDA's network. Training and construction materials are also obtainable for field staff without difficulty. Less established agencies in Thailand would probably not have the same flexibility and access to such external resources. In this case, the existence of a proper design with visible examples undoubtedly gave CBATDS staff and villagers substantial confidence in pursuing the scheme.

d. The degree to which the organization is able to retain autonomy and control of the adoption process is positively related to the project's results. Virtually all the critical factors in this project -- control of funding, selection of participants, technology choice, organizational structure -- were vested in the organization. This undoubtedly featured strongly in the success and stability of the project to date, particularly in overcoming inertia, regulating unscrupulous material suppliers, enabling timely flow of resources, etc. The relatively moderate achievements of CBATDS's Dry Seasons Public Works Project

with local sub-district governments provide an interesting contrast to this project. CBATDS to date has only provided technical assistance to these water supply schemes for public facilities (schools, temples, etc.) as the local governments prefer to keep control and accountability of funds within their hands. The quality of workmanship, not surprisingly, of these hired labor schemes is much lower than in identical work performed by owner-builders, and maintenance and use standards appear to be much less scrupulously observed.

2. Hypotheses concerning the state of the technology.

a. The degree to which the technology is tolerant to errors in manufacture, in use; to adaptation by the user, to substitution of materials, fuel, etc., positively influences its adaption. As noted by Bruns (1981) the large rainwater tanks are clearly overdesigned from an engineering standpoint. More cement is used than required for minimal concrete strength. In particular, thinner walls, including possible bamboo and ferrocement construction, could alternately have been utilized. As Bruns explains, the designs reflect the realities of construction standards and techniques under village conditions, and deliberately allow for wide tolerances due to poor concrete mixing and curing, substandard building materials, inexperienced labor, etc. Both the large tanks and water jars allow for further adaptation by the user, i.e., installation of supplementary downspouts from additional roof-slopes.

b. The degree to which the technology uses local materials and human resources positively influences its adoption. The central feature of the project -- mobilizing construction teams combining self-help incentives and peer pressures -- has reinforced cooperation in the villages, reduced costs dramatically, and made the construction process an enjoyable one. While emphasizing optional use of locally available resources, CBATDS did provide special equipment such as metal mixing boxes, which saved considerable amounts of cement. CBATDS was frequently required to provide special supports, such as bulk purchase and delivery of special items unavailable or prohibitively expensive in the villages. Streamlining the dissemination system in this fashion optimized local resources and reduced risks and obstacles substantially for prospective users.

c. The degree to which the technology builds on traditional knowledge and patterns positively influences its adoption. That is, incremental technology change is to be preferred to large departures from traditional patterns. Villagers have traditionally

collected rainwater in a variety of containers and exposed basins in areas where externally financed large-scale systems are non-existent and groundwater supplies are inadequate or unacceptable. According to a 1979 USAID evaluation of rural potable water projects in Thailand, only 15% of the rural population lived in areas serviced by such systems. (Dworkin and Pillsbury, 1980.) The authors of that study and CBATDS field staff have both concluded that low-lift hand pumps have not found much acceptance as communities have generally not regarded them as a significant improvement over the ubiquitous rope and open bucket system.

Additionally, in many areas of the Northeast, villagers have separated drinking water from water for other uses such as washing and irrigation and often procure these from different sources. The saline groundwater is not suitable for all uses. Thus, the 11.3 cubic meter bamboo-reinforced water tanks, or a series of 2 cubic meter jars have emerged as the most efficient technologies for storing rainwater for household use in Northeast Thailand. While not a quantum technological change for most users, the collection and storage vessels have proved to be durable, convenient, and capable of satisfying drinking water needs given adherence to a careful rationing regime during the dry season. Neither construction techniques nor operating maintenance of these technologies is a significant departure from past practices.

d. The degree the technology has been field proven in relevant settings positively influences its adoption. Since their initial appearance in Northeastern Thailand in the early 1970s, bamboo-reinforced concrete systems have been successfully introduced at scattered locations, primarily public facilities such as schools and health clinics. Privately owned self-financed tanks were rarely installed, primarily due to lack of organizational, technical, and financial support. CBATDS in its pilot project was able to organize the dissemination system and introduce a critical and credible presence of installed tanks in several villages in Khon Kaen and Mahasarakham provinces. This has helped to create a threshold of popularization which enabled expansion of the program within villages and across village lines. Despite occasional failures due to faulty construction and poor maintenance, confidence in the technology has been generated throughout Northeastern Thailand through CBATDS direct promotional activities and spontaneous information exchanges.

3. Hypotheses concerning the role of external organizations and resources.

a. The degree to which ownership of project decisions related to technology is transferred to those responsible at a local level positively influences its adoption. The CBATDS's rainwater tank project partially reflects this hypothesis. Once general technical and organizational feasibility studies indicating geographical target and technology areas had been undertaken by Bangkok staff during CBATDS's planning phase, local needs assessment surveys were conducted by field staff. These surveys established the basis for focussing resources on rainwater collection potable water systems. Thereafter, within the pilot introduction project in Northeastern Thailand, the dissemination scheme and attendant technical details were essentially devised by CBATDS local staff. However, a significant amount of control over funding mechanisms and resources is still being asserted by PDA.

b. Flexible grant requirements and the ability to operate in a responsive mode enhance the chances for success. Flexible grant requirements allowing experimentation and a maximum of operational independence were largely responsible for the results achieved to date, according to CBATDS's management. Initial external funding agencies (ATI, the Canadian Embassy, and the Ford Foundation) allowed CBATDS to evolve its programming focus in a sequential and systematic way, narrowing the focus on specific target populations and technologies. Thereafter, larger amounts of external financial assistance could be absorbed by CBATDS (Agroaction Tungnam I & II projects) and used for wide dissemination of the rainwater tanks. The conditions of these large operational grants also allowed a great degree of operational flexibility. For example CBATDS was able to convert grant monies into a revolving fund for soft loans to finance the construction of further tanks. The terms by which the loans are extended to local villages allow in principle for the financing of related technology (e.g., water and sealed latrines), which may enhance the public health impact of the project.

c. The degree to which use/dependence on external resources are replaced by local financial, technical, and organizational resources is positively related to success. This hypothesis is as yet unverifiable. The primary reasons for the relatively wide dissemination of the technology are that costs, risks, and various obstacles to potential users have been substantially reduced by CBATDS's logistical, technical, and financial support systems. Certainly, locally available materials, tools, and labor have been optimized and the organizational structure of the project

is well established at this time in Khon Kaen and Mahasarakham Provinces. Local management, if unimpeded by internal and external pressures, could establish a stable, long-term presence in Northeastern Thailand and continue dissemination of the technologies indefinitely, given orderly recirculation and replenishment of financial resources.

Other Issues

Substantive progress has been achieved within the CBATDS's rainwater tank project. Momentum and organizational capacity have been established on the local level to overcome the inertia that pervades many other small-scale technology adoption efforts in Thailand. The dissemination process will soon be routinized, provided that major internal and external financial and organizational disruptions do not occur.

Appropriate technology -- understood as technology that is adjusted to local materials, skills, and traditions -- has had uneven success in the country. To those familiar with the term, appropriate technology often conjures up images of prototype devices such as windmills and chain and washer pumps located at demonstration facilities or "AT museums." In contrast, many traditional local industries, producing such items as the concrete tanks and clay water jars discussed here, do display technical and commercial vitality, although access to them may be restricted by relatively high costs. While standards and expertise at Thai universities and research and development facilities are quite high, technologies developed there are being extended to rural Thailand at an extremely slow pace.

While Thailand has been successful at reproducing imported technologies for which manufacturing and distribution can be standardized, many appropriate technology devices and centers observed in the country do not inspire confidence. Often little effort is made to adapt technologies and develop them under local conditions because project staff people have inadequate design and testing skills, a limited feel for materials use optimization, systematic production techniques, and quality control, and little "social marketing" acumen. The result is that local people are reconfirmed in their belief that technologies produced with local materials and skills don't work very well, are expensive, require frequent maintenance, and don't last very long (Sherman, 1982).

The CBATDS's rainwater tank project could counteract these perceptions. Many of the reasons for this have been already discussed in this report. It should also be pointed

out that to date the rainwater tank project and the marketing scheme are the only CBATDS's projects which have actually begun to realize the potential of the PDA village-based family-planning services delivery system. (All CBATDS's projects were to use that system.) Several issues arose during the field survey, which will be discussed here to present a balanced account of the potential and limitations of this project.

Stability of staffing. PDA, CBATDS's parent organization, has generally staffed the programs of affiliated organizations by transferring and promoting from within PDA. This means that most CBATDS personnel has served within CBFPS, PDA's family planning arm. It is unclear whether programs staffed in this manner have the required technical, financial, or managerial skills. Also unclear is whether the frequent transfer of staff from one position to another within the constellation of organizations actually heightens morale and prevents role stagnation as it is designed to. Some say it leads to instability within the organization, but generally it is thought that frequent transfers expose individuals to various PDA programs and promote a common understanding. Nevertheless, the vacuums and operations gaps that may arise (as precipitated by the illness and departure of Dr. Malee Sundhagal) do point to possible significant problems in the future if this practice is not modified.

Due to PDA's current growth phase, new staff members for CBATDS are also being recruited from outside, and it will be instructive to ascertain how effectively they can be integrated.

Incentives for field workers. As this project achieves momentum and recognition, field workers get more and more direct satisfaction from their activities. Volunteer labor, particularly if contributed by technician trainees, can be extended quite far without additional compensation. However, special incentives for field workers to provide preventive maintenance and continue approaching their work with equal enthusiasm in the future do not appear to be factored into CBATDS's programs. Maintenance has to compete with training, construction of new tanks, and other activities (Bruns, 1982). One person interviewed linked the lack of support for such incentives to PDA's centralized decision-making and concern for reputation, perceived as equally evident within the organization's administration and Thai society in general. Despite the fact that each new tank owner is provided with preaddressed and stamped cards to be mailed in for follow-up maintenance, it is not clear that this system can assure exacting adherence to standards and prompt frank feedback from users. Additional incentives, bonuses, and further decentralization may become necessary before too long.

Management/control of funds. In the face of an increasing demand for services and a rise in the level of activities, the project needs more autonomy. Current practice, where central management has assumed a proportionally larger share of responsibility for budget allocations and disbursements, may require revision. The appointment in March 1982 of PDA's dynamic and charismatic leader, Meechai Viravaidya, to the chairmanship of a government commission, the Provincial Water Works Authority, may create an opening for creative decentralization without overt disruption of field programs. Decision-making at the local level for such matters as more flexible allocation of resources for bulk purchases of building materials, would seem to be an improvement over the current situation.

Equally important is transferring authority from the field staff to the local people participating in the project. Although such a transfer has often been discussed in relation to the revolving fund, little progress appears to have been made to date. It may well be that while village people regard CBATDS project staff in familiar and favorable terms, status differences remain and form barriers to communication (Bruns, 1982). Project staff were of the opinion that few of the villages where projects had been carried out had the technical and organizational capacities to manage small scale funding programs. Close monitoring of the loan collection records over an extended period of time should help determine how this situation will evolve.

Equity of water supply. The project has increased drinking water supplies to 1,200 to 1,500 families in Northeastern Thailand. This achievement would probably have been impossible without the CBATDS's project. The government has encountered slow progress in constructing rainwater tanks. Virtually all of these tanks are built for community facilities where lower standards of construction and maintenance have been observed. These tanks cost more per unit than CBATDS's installations with no recovery of costs possible, as there is with a revolving loan fund. The CBATDS's rainwater tank project supervisor cited two examples of villages which have used excess funds and building materials to construct an additional tank for the use of families unable to afford their own. Most of the families interviewed who participated in the construction of their tanks share the water with members of their extended families, relatives, and occasionally non-related individuals.

In the course of various interviews, it was made evident that the villages where systems had been installed and the families participating in the program do not rank in the lower economic strata. The screening process involved in the selection of participants results in excluding families who cannot afford the modest ฿300 to 500 ($15 to 25) down payment and the subsequent

฿100 to 200 ($5 to 10) monthly payments for the large bamboo reinforced concrete tanks. CBATDS has recently been promoting the large red wire-reinforced as an alternative to the larger tanks. Initial costs and installments are lower, and CBATDS has established that this technology is lowest in cost per unit volume. An inherent aspect of the process employed by CBATDS in disseminating the tanks or jars through owner financing is that they will not be affordable and accessible to all villagers. However, CBATDS's manager has indicated that 30 tanks installed out of 100 households in a village would provide enough drinking water for practically the entire village. One foreign technical advisor interviewed mentioned that despite CBATDS's role as a more benevolent intermediary, it might be subject to the distrust rural Thais display towards outside business concerns.

Continuity of demand and replenishment of resources. The sustainability of the project is contingent on a balance between demand for the technology by villagers and the organization's ability to supply technical, organizational, and financial support to them. All current projections for the Tungnam II project financed by Agroaction of Germany are based on the block grant revolving fund concept which is its key feature. With overhead at approximately 40% of total budget funds, the revolving fund will eventually diminish even if the current high loan repayment rate continues and most new loans by villagers are designated for water tanks or jars. This implies that some form of replenishment both for CBATDS's overhead and further loan funds will be required to maintain the current level of effort. All of these calculations are based on the assumption that demand for the products will remain steady. However, demand within the existing operational areas may peak off if they become "market saturated," or if government sponsored schemes extend to them, or if deep wells become a more economically feasible option. Then operations would have to be moved to other locations where unanticipated start-up costs may arise. For these reasons, the project should have longer-term contingency plans.

Relation to other development programs. None of CBATDS's other technology promotion activities has achieved the rate and scale of acceptance as the water tank project. For probably sound administrative reasons, CBATDS has set up the Tungnam project as a distinct program within itself, with staff primarily but not exclusively concerned with the dissemination of rainwater tanks and jars. The concern was expressed by some persons outside of PDA that this project may have a unique visible and actual level of success unachievable by other CBATDS ventures. The reasons cited for this view include

the circumstances surrounding the technology and the huge amounts of foreign funding completely under the organization's control specially earmarked for this project. This view, however, may reflect a distrust and/or envy of PDA's scale of operations and access to external and internal funding resources and logistical support.

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