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Rainwater storage in cement jars in Northeastern Thailand

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The supply of drinking water in the rural Northeast of Thailand has long been a problem. Since the early 1980s the government has promoted 2000 l cement rainwater storage jars for drinking water. Examined here are issues related to the government's programme: jar acquisition and ownership; construction quality; use of jar water; rainwater collection systems and access; water quality; taste preferences; and water storage and shortages. It is found that, while having problems, the programme has been successful: village water storage capacity has increased; villagers are drinking better-quality water for longer periods; and the acceptance of jars has improved.

The Northeastern region of Thailand, often subject to long dry seasons and unreliable rainfall, has since the early 1950s been a target area for government water resources development. The programme accelerated during the counterinsurgency period of the 1960s and 1970s as the Communist Party of Thailand was strong in this, the poorest region of the country.

Even so, by the early 1980s surveys showed that many villages in the Northeast still lacked adequate and safe drinking water throughout the year. For example, one planning document indicated that only 14% of the population had access to such supplies (at 5 l per person per day) in 1983 (AIT, 1985, p 34).

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In response, the fifth and sixth five-year development plans, coinciding with the International Drinking Water Supply and Sanitation Decade, intensified efforts to solve the Northeast's drinking water problem. A major vehicle in this has been the humble rainwater jar.

The jar programme

Northeastern villagers traditionally stored rainwater for consumption in small clay jars, but during the dry season obtained drinking water from shallow wells and ponds. In the mid-1970s, realizing the social acceptability of rainwater (groundwater from tube-wells being unacceptable due to high salt or iron content) and the potential of rainwater catchment as increasing numbers of houses used metal roofing, researchers began experimenting with the construction of large-capacity (2000 l) cement jars.

It was found that the use of jars for rainwater collection was cost-effective, and that jars were simple to construct and maintain. In addition, the quality of the water was better than that from shallow wells and surface facilities (AIT, 1985, p 46; (TAVWS, 1985, pp 47-54). The Department of Health had been promoting cement jars in designated poverty areas (Tunyavanich *et al*, 1985), but it was decided to expand this to a national rural rainwater collection programme, and provide 5 million

large-capacity jars by 1987. At one jar per household, a daily drinking water allowance of 3 l per person could be achieved for the whole country. A careful implementation programme was devised, with the Northeast being a major target area (Faculty of Engineering, Khon Kaen University, and NEVWRP, 1987, pp 23–25).

Millions of jars were purchased, distributed or constructed: in 1983 large jars were so uncommon that they were not usually enumerated, but by 1988 there were 9 million jars throughout the country (Government of Thailand, 1989, p 33). In the Northeast the programme was widespread: in Mahasarakham province, where there were about 80 000 jars in use during 1985, by May 1987 there were 213 000 (Hewison, 1987).

Early reports indicated that some villagers suspected the quality of jar construction, while others objected to the 'cement' taste of water stored in jars (Tunyavanich *et al*, 1985). This article discusses the use of cement jars and changing attitudes towards them.

Studies

The two studies which form the basis of this article were completed for the Thai–Australian Northeast Village Water Resource Project (NEVWRP). That by Hewison (1987) was based on a sample of 85 households in 12 villages in a district of Mahasarakham province. The second was conducted in Yasothon province by a team led by Dr Nongluk Tunyavanich (1989) of Mahidol University, surveying 300 families in seven villages.

Jar acquisition

During 1986–87 in Mahasarakham province the most common method of acquiring jars was through the Rural Employment Generation Programme (REGP) or some other government support project (90.8% of households). In Yasothon province, while two thirds of households reported buying jars, almost all purchases were at reduced prices due to government support. Most people also acknowledged the central role of officials in encouraging them to acquire jars, although the most common reason for acquisition (40% of respondents in Yasothon) was to increase water storage capacity.

In Mahasarakham it was clear that the jar programme's potential for engendering community participation was not fully realized. The campaign nature of the government programme meant that villagers believed they had little choice but to request jars under the REGP; many felt that if they

did not they would get nothing. This seriously undermined the REGP objective of developing the efficiency of sub-district councils in the planning process (Surarerks, 1986). If there is no choice, then there is no meaningful 'bottom-up' planning, and participation will be token. Other programmes encouraging the acquisition of storage jars, such as village development funds, were not always successful. Even though a majority of people were aware of the existence of such funds, many villagers believed that the funds were mismanaged, and that petty corruption was involved. Nevertheless, jar ownership increased markedly.

Jar ownership

In Yasothon factors such as levels of education, income, occupation, water shortage problem and taste preference were analysed statistically, but were not found to be significantly related to the ownership of cement jars. A significant relationship was, however, found between ownership and having attended training about drinking water and sanitation (eg sanitation craftspersons or health volunteers). Households with experience of government-sponsored training owned more jars than households with no such experience. In addition, as expected, people from households with cement jars were more likely to prefer drinking water stored in cement containers than those without such jars. Likewise, households with cement containers, or planning to have them, or where household members had attended training concerning water, had a more positive attitude towards the jars than others.

Construction quality

Jar construction quality has not always been good, and varies by location, by agency involved, and over time. For example, in 1987 36% of villagers surveyed in Mahasarakham reported either breakages or leaks, but only 16% of respondents in Yasothon reported these problems in 1988.

Water use

Utilization of jars varies between the wet and dry seasons. While jars do not require large quantities of rainwater to fill them, almost a quarter of villagers surveyed in Mahasarakham reported that at the end of the wet season their jars were not full. At the same time 43% of these people stated that they did not have sufficient capacity for the whole dry season. This was confirmed in Yasothon, where only 47.7% of households stated that they had rainwater left for drinking in the dry season, and that empty jars were generally not replenished from other sources. Wet

Table 1. Uses for jar water, Kae Dam district, Mahasarakham.

Use	Percentage of households reporting use
Drinking water ^a	87.9
Water for cooking	79.5
Washing clothes	36.1
Bathing	33.7
Washing dishes	7.2
Have jars but do not use them	2.4

^a9.6% of surveyed households reported that they have jars but do not drink from them.

season utilization was uniformly high. It may be concluded that the majority of large cement jars are fully utilized to store drinking water only when there is rainwater to catch – mainly during the wet season. One reason for this pattern is that jar water is not always rationed, nor is it used exclusively for drinking (see Table 1).

Nevertheless, water storage capacity has increased. In the Yasothon study villages a census of storage capacity was taken in 1984 and again in 1988, with the average household drinking water storage capacity increasing from 783 to 1818 l. In Mahasarakham, where only large-capacity jars were considered, the average household storage had increased from about 460 l in 1985 to almost 5 000 l by mid-1987. That these increases were due to jars is striking evidence of the success of the government campaign.

Once stored rainwater is depleted, villagers inevitably return to shallow wells – 82% in Mahasarakham and about 70% in Yasothon. However, the impact of the jar programme can be seen in Yasothon, where villagers reported exclusive use of rainwater for 4.2 months in 1984, but by 1988 this figure had risen to 5.5 months. Another indicator of change was the number of people drinking only rainwater during the dry season, which increased from 2.7% in 1984 to 9% in 1988. This suggests that in other areas where the programme has been more widespread – in the surveyed villages in Yasothon only 44% of households had large-capacity cement jars – the impact has been even more significant.

Access and collection systems

Health authorities recommend that jars be constructed with taps, drainage plugs and lids (see Figures 1 and 2). If these are present the risks of contamination from the roof and unhygienic handling practices are minimized (AIT, 1985, p 46). In Mahasarakham, however, it was found that 72.3% of jars did not have taps, and access to the water was by bucket (35.8%) or siphon hose (34.9%). Villagers are, however, concerned about taps: in Yasothon the vast majority of respondents in 1984 (86.7%) and 1988 (97%) agreed that a tap improved the *convenience* of jar use. However, villagers have also reported problems with taps: they are difficult



Figure 1. 2000l cement jar with lid and netting.



Figure 2. Water jar with lid.

to repair; children play with them and waste water; and animals lick the tap; discouraging human use.

Lids were found to be in wide use in Mahasarakham, with 88.5% of jars having some form of cover. It seems that even with this high coverage, however, there may still be problems. For example, villagers complained of increased mosquito infestation. While there is no conclusive evidence that this is related to the jars themselves, it is possible that the increased availability of water within villages may be adding to the breeding places for some varieties of mosquito. An examination of a small sample of jars (by non-specialists) indicated that jars with lids are less susceptible to larval infestation than those without lids (Hewison, 1987, p 17). As a result of concerns about mosquitos and for filtering debris from roof runoff, netting of jars has been recommended.

After taking water from jars, nine out of ten respondents reported decanting it into smaller containers. Villagers do this in order to improve the taste of the water, for convenience of access within the household, and to keep drinking water cool. In doing so, however, they increase the risks of bacteriological contamination through handling (Pinfold, 1988; Wirojanagud *et al*, 1989).

One advantage of jars over traditional water sources is their convenience. For most Northeastern villagers the collection of water is an arduous and time-consuming activity, usually completed by

women and children (Sirisambhand and Gordon, 1987; Tunyavanich *et al*, 1987, pp 54–57). Collecting water from ponds and shallow wells will sometimes involve a trip of several kilometres, collecting and pushing or carrying up to 120 l of water at a time back to the house. Jars, usually situated next to the house, are more convenient. In some villages this 'convenience factor' is even more important as the majority of working-age people will leave their homes in the dry season in search of paid labour elsewhere. This leaves old people and young children in villages for long periods of time; hence the convenience of jars is advantageous.

Cleaning and water quality

In the Mahasarakham survey almost 90% of villagers stated that they cleaned their jars, and a physical inspection confirmed that jars were usually clean, with only a few instances of dirt, algae or debris. Villagers do seem to have a concern for cleanliness, but it was noted that cleaning could be burdensome as the jar had to be emptied. The fact that an adult can easily look inside a jar means, however, that the jar's condition is readily seen.

Prior to the implementation of the jar programme it was feared that rainwater would be contaminated by debris from the roof collection systems (AIT, 1985, p 23). Indeed, as it has turned out, only a third of people in Mahasarakham indicated that they cleaned their roof catchments. But it was also found

that most villagers (94%) ran off at least the first rains, thus flushing the system. This probably reflects a traditional practice of allowing water to run off thatching until it is clear, prior to collection.

In spite of this concern for cleanliness, and a feeling amongst villagers that water in cement cisterns is generally clean (in 1988 in Yasothon 93% of respondents stated this), problems of quality remain. Water quality technicians have reported that while the physical and chemical quality of samples collected from jars meet the 1971 WHO drinking water criteria in 90% of cases, only 29% met the bacteriological criteria (Government of Thailand, 1989, p 39).

This is surprising, for a range of studies had shown different results. For example, studies by AIT (1985), TAVWS (1985) and Sakunphram *et al* (1987) indicated that faecal contamination of cement rainwater collection systems was not great. Wirojanagud *et al* (1989) have demonstrated that if criteria suitable for tropical countries, such as *E. coli*, (Helmer, 1989; Malik, 1988) are used, only 12% of sampled rainwater stored in cement cisterns ($N = 189$) did not meet WHO criteria.

Even this small problem is mitigated by three factors. First, recent studies have shown that the bacteriological quality of water improves markedly with only short periods of storage, as bacteria tend to die off (eg Chuthamaniphong, 1988). Second, it can be assumed that where villagers were previously abstracting water from *public* sources having a high propensity for bacteriological contamination – surface water and shallow wells – the move to *private*, household-level facilities reduces the risks to public health. Third, it has been demonstrated that whatever the quality of jar water, by the time it is decanted several times prior to consumption handling contamination will occur, and may be more significant than contamination at source (Pinfold, 1988; Wirojanagud *et al*, 1989). Thus efforts by health authorities to chlorinate jar water are doomed to failure: hygiene education is the most appropriate vehicle in overcoming this problem.

It may be concluded that the collection of rainwater in cement jars is likely to have a significant health outcome, and that this outcome will be greatly enhanced by appropriate sanitary practices.

Taste

The taste of water stored in cement jars was an issue when the jar programme was initiated. The surveys in Yasothon in 1984 and 1988 indicated broadly similar results for taste, with about three quarters of respondents choosing rainwater as the 'tastiest'

Table 2. Comparison of attitudes (%) towards drinking water stored in cement containers, Yasothon province, 1984 and 1988.

Attitude	1984	1988
Negative	10.3	7.3
Neutral	70.0	60.0
Positive	19.7	32.7
Total	100.0	100.0

water.¹ However, when the choice was between rainwater stored in cement containers and shallow well water, significant reductions in taste acceptability were noted, with only about two thirds of people choosing the stored rainwater. Nevertheless, the response indicated that the percentage of people choosing rainwater, whether stored in cement containers or not, had increased marginally between 1984 and 1988. This is probably due to the fact that more people had experience of drinking water stored in cement containers (up from 55% in 1984 to 71.4% in 1988).

While the comparison of attitudes in 1984 and 1988 towards drinking water stored in cement containers encountered some methodological problems due to the changing situation in the study villages, some significant results were achieved. It is clear that more people now have a positive attitude to drinking water stored in cement containers. Only one fifth of respondents had a positive attitude in 1984, but by 1988 this increased to almost one third. The number of people who were 'neutral' also decreased from 70 to 60%. Many of those who were 'neutral' in 1984 had changed to being more positive in 1988. Again, the reason for the change would seem to be that more people now have experience with cement containers (see Table 2).

For taste, it was found that while in 1984 48.9% agreed that rainwater stored in cement jars was 'tasty', by 1988 this had decreased to 36.7%. Similarly, when presented with the statement: 'Rainwater in cement jars is not "tasty"', 69.4% agreed in 1984 and 66% agreed in 1988. This is not conclusive. In 1984 only small numbers of households had cement jars and about half of the respondents said the water stored was 'tasty'. In 1988 almost half the households had cement jars, but the percentage of people who thought the stored water was 'tasty' was lower than in 1984. This may reflect the fact that those who had cement containers in 1984 were the

¹This is not necessarily typical of the whole Northeast; Phithakmahaket and Sunthonthada (1986) found that the preferred drinking water was from shallow wells.

'pioneers', and more receptive to water stored in this manner. However, by 1988 ownership was more widespread after vigorous promotion, and thus there was a much wider cross-section of opinions to be assessed.

This is confirmed by the fact that the percentage of people who stated that they would never drink rainwater stored in cement cisterns or who found the taste 'sour', 'bitter' or in some way 'bad' had been reduced from 14.6% in 1984 to just 5% by 1988. Similarly, by 1988 almost half of the respondents felt that water stored in cement jars was as 'tasty' as that stored in ceramic jars. Indeed, by 1988 cement jars were the preferred kind of cistern (see Table 3).

It became clear that the unpleasant taste associated with cement cisterns was restricted to newly constructed facilities. Once they had been used for a season or more the 'cement' taste was much diminished. Some villagers even developed methods they believed hastened this process: washing the inside of the new jar with vinegar; rubbing it with banana leaves or lime skins; some even threw a handful of clay from their favourite well into the jar, to give it an 'earthy' taste.

These results indicate a clear tendency: rural Northeasterners are coming to see rainwater stored in cement containers as convenient and acceptable for drinking. More households now have and use the facilities and less people have negative opinions towards water stored in cement containers.

Storage capacity

As villagers have now been drinking rainwater for far longer, increased storage capacity is to be expected. In Yasothon it was found that households now have more water storage containers of various types. More than 40% had six or more ceramic jars (capacity 160–240 l) in 1988 compared to only 25.4% in 1984. The percentage of households with large cement jars also increased: only 3.9% of the households had these in 1984, rising to 44% in 1988.

As noted above, there have been huge increases in rainwater storage capacity in the surveyed areas.

Table 3. Desirable types of drinking water storage cistern (%), Yasothon province, 1984 and 1988.

Type of container wanted	1984	1988
Small clay and ceramic jar	13.2	14.4
Big cement jar	19.3	36.1
Cement tank	41.0	18.7
Combination of above and zinc tank	11.4	1.0
Nothing	15.0	29.8
Total	100.0	100.0

The reason for such increases in water storage capacity, as noted by participants in focus group discussions, was that there were now many agencies campaigning for all the households to have cement jars. This, coupled with the convenience factor, means that households which could afford jars quickly acquired them.

Water shortages

As water storage capacity has increased, stored water for drinking has lasted longer. Thus more people respond that they no longer have water shortage problems. In 1984, 29.6% of households in Yasothon stated that they did not have a drinking water storage problem, but by 1988, 37% believed they had sufficient drinking water. The majority of people still thought they had a drinking water shortage problem, but those who said they had a 'severe' shortage problem decreased considerably (see Table 4).

In Mahasarakham, where the jar programme was more extensive, only 5% of respondents said they had insufficient storage capacity. Conversation with villagers showed, however, that many felt 4000 l (two jars) was not sufficient, and that 6000 l would be more realistic.

Conclusions

This article has summarized some findings concerning the use of large-capacity cement water jars in Northeastern Thailand. The focus has been on user behaviour and attitudes.

It is noteworthy that, in spite of management problems, its campaign nature and the lack of community participation, the government's jar programme has generally been successful. By the government's own measures – jar counts – the increase in the number of jars in rural areas has been remarkable. While villagers in the Northeast do not always agree that drinking water is a major problem, and would prefer to improve agricultural water supplies (Phithakmahaket and Sunthonthada, 1986), there is an acknowledgement that the introduction

Table 4. Identification of drinking water shortage problems in the household (%), Yasothon, 1984 and 1988.

Level of problem	1984	1988
Severe problem	20.7	13.0
Moderate problem	33.3	22.7
Little problem	16.4	27.3
No problem	29.6	37.0
Total	100.0	100.0

of jars has improved their drinking water situation. Indeed, most villagers would now prefer cement jars to any other drinking water storage facility, and are drinking rainwater for longer periods. It also seems that villagers prefer to purchase ready-made jars rather than have them constructed in the village.

Villagers remain, nonetheless, critical of some aspects of the programme. First, they continue to object to the cement taste of jars, although this is reduced with time. Second, they are confused by the lack of coordination amongst government agencies, and the lack of quality control in jar construction. Third, while agreeing that their situation has improved, most villagers still note a drinking water shortage.

There remain aspects of jar use which may be of significance for health. First, villagers generally do not ration water in the dry season, and return to less sanitary sources. Second, many jars do not have taps, meaning that water abstraction can lead to contamination. Third, water from cement jars is usually transferred to other containers prior to consumption, thus increasing the chances of contamination (Pinfold, 1988). Nevertheless, it should be admitted that jars are now (and potentially) a more sanitary source than the traditional alternatives, and villagers generally agree that the water is 'clean'.

It does not appear that there are many social or demographic factors which indicate a propensity to acquire cement jars. Those factors which seem significant are: (1) economic development – it appears that as the general level of economic activity increases, villagers are less willing to spend time collecting water; (2) convenience – people like the ease of access to jar water; (3) knowledge – those people who have attended some kind of training related to water supply are more likely to own cement jars; and (4) experience – those people who already have cement jars are likely to acquire more.

It may be concluded, then, that jar acquisition should continue to be emphasized in the Northeast, and that health education be given a high priority in order to maximize the potential health benefits of increased jar ownership. Hygienic water user behaviour, both at the jar and within the household, must be emphasized.

All agencies, private and state, working towards the promotion of village drinking water provision should implement their activities using broadly similar methods so as to avoid confusion among villagers. Stress should be put on quality control and pricing of facilities so that there will not be great variations. Taps, lids, nets and drainage plugs should be standard features of all jars, whether ready-made or village constructed.

In government programmes, community participation should be further promoted, with village and sub-district decision making being encouraged.

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