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## **Managing Water Supplies and Encouraging More Effective Irrigation Practices in Cambodia**

### *Introduction*

Cambodia is a land caught in a brutal cycle of difficult recovery. Situated on the mouth of the Mekong River, this Southeast Asian country has been the victim of internal strife and dictatorial regimes that have made food security extremely difficult. The Khmer Rouge regime, which held power until the mid-1990s, introduced irresponsible agricultural and economic practices that left a vast majority of Cambodia's people impoverished. Although recent years have seen a remarkable recovery of political stability, Cambodia continues to be plagued by quandaries in the agricultural sector. In particular, the lack of effective water management has proved to be a major setback in further agricultural development and recovery.

Because of its geographic location in the tropics and along lush river lowlands, Cambodia is actually considered to be a water-wealthy region. However, because of poor water-management and irrigational practices, most of the nation's farmers struggle to acquire adequate water supplies. This problem, coupled with seasonal droughts, inconsistent rainfall, and lengthy dry seasons, has seriously disrupted the region's agricultural-based economy and wrecked havoc on its populace. In accordance with the United Nations Millennium Development Goal to "eradicate extreme hunger and poverty", decisive action must be taken to ensure consistent water supplies for Cambodia's farmers.

Two options that could reverse Cambodia's trend of water scarcity and resolve irrigation problems are government investment in gravity irrigation systems at the local level and more responsible management of water resources at the national level. Both will allow local communities to develop agricultural production and increase crop yields, while simultaneously creating an efficient and widespread irrigation system that can be sustained for long-term growth and development. These implementations have great potential to dramatically improve the financial standing of rural farmers, and therefore move one step closer to eliminating hunger and starvation, in Cambodia and around the globe.

### *Current Situation of Rural Cambodian Farmers*

According to Neak Oknha Reththy, Vice President of Cambodia's Chamber of Commerce, an estimated 85 percent of Cambodia's 14 million people live in rural regions and is dependent upon agricultural cultivation as their principal means of sustenance (Reththy 1). In addition, roughly 35 percent of Cambodia's population is below the poverty line, and poverty is much higher in rural areas (World Food Programme).

Rice supplies nearly 75 percent of total caloric intake, and fish is the chief supply of protein ("Utilization of Food"). These two foods predominate due mainly to their abundance in Southeast Asia and their importance in traditional Khmer diet. Both of these staple foods are highly dependent upon Cambodian water supplies, therefore making the need for viable irrigation systems great.

Education remains an issue of importance in rural areas. Overall, Cambodia's literacy rate stands at just 73.6 percent, and rates are much lower in the poorest rural areas (CIA Factbook). Further, there is a major imbalance between male and female education: the male literacy rate is 84.7%, while the female literacy rate is just 64.1%. The low education rate among rural populations is caused mainly by inadequate government funding and mismanagement at the local level, which have created problems such as lack of facilities, inability to pay teachers, and lack of supplies ("Culture of Cambodia"). This, coupled with the need of poor farm families to keep children at home to labor, has resulted in relatively low literacy rates and education among rural populations. In the context of water management, this lack of education is especially threatening, because it indicates that peasant farmers aren't receiving sufficient training in effective irrigation and water resource usage.

The average farm size for the rural farmers in Cambodia is about 1.5 hectares. However, 40% of the rural population lives off less than 0.5 hectare, which is inadequate to meet per capita rice needs, and 21% are thought to have no land ("Rice Country Profile" 2). Cambodia's leading crop is rice, which is cultivated on more than 44% of Cambodia's total arable land. Most Cambodian rice farmers still engage in backward agricultural practices. Traditional paddy farming is used to grow rice, but in many cases water is not used efficiently and output is well below yield potential. In addition, most Cambodian subsistence farmers are too poor and isolated to obtain modern agricultural technology. As of 2001, there were only 20 threshers and 1,855 tractors in the entire country ("Rice Country Profile" 1), and as a result, Cambodian villages continues to rely on draft animals and primitive tools in rice cultivation.

Agricultural productivity has been slow to develop in Cambodia because of several inhibitory factors that prevent subsistence farmers from breaking out of poverty and increasing income. Many have found it difficult to acquire the tools and draught animals needed to effectively grow crops. The farmers fortunate enough to have such tools are still not wealthy enough to invest in modern technology, so they are basically "trapped" in low levels of agricultural production. Underdeveloped irrigation systems make it difficult for farmers to harness the monsoon rains of the wet season from May to October, so farmers are often short on water come the dry months from November to April (Thuch).

#### *Problems and Implications of Water Mismanagement*

As Chann Sinath, Deputy Director of the Irrigated Agriculture Department of Cambodia, observed, "Irrigation supports agriculture, and therefore the achievement of food security, poverty reduction and socio-economic development" (Sinath). Irrigation is vital to the growth of any nation's agricultural sector because it is responsible for the controlled distribution of water resources to crops. At first glance, it would appear that Cambodia, which receives 60 to 80 inches of rainfall each year, contains all the water it would ever need to power agricultural expansion. Unfortunately, this is not the case. In fact, managing water scarcity and resources is proving to be one of Cambodia's largest and most serious problems. The FAO and the Irrigated Agriculture Department of Cambodia estimate that only 16 percent of total cultivated area possesses irrigation systems, and that the country is utilizing just 1 percent of total water resources (Sinath).

The irrigation problem can be traced back to the Khmer Rouge regime of the 1970s and 1980s. State leaders mandated that rice become the center of Cambodia's economy, and farmers were forced to construct irrigation trenches during the dry season. During this process, the few people who had the technical knowledge to create an effective irrigation system went into hiding, fled the country, or were

killed by the brutal regime (Sinath). As a result, irrigation trenches were not built according to natural land contours (which would have been most efficient), but instead on a grid coordinate system. This created a “chessboard” of irrigation canals, a system that was doomed from the start. The canals were built with no regard to basic engineering and hydrological principles, resulting in mediocre performance (Sinath). Entire sections of canals were disconnected or sloped at different angles down the slopes. In the worst cases, traditional drainage and water distribution patterns were disrupted, and irrigation structures were destroyed or damaged by sporadic flooding.

The issue is largely a problem of two extremes: there is an overabundance of water in the wet season and a shortage of water during the dry season. In the dry season, there are not adequate facilities devoted to the conservation and management of limited water supplies. Conversely, during the wet season, current irrigation systems cannot control and distribute water for supplemental irrigation, and are inadequate for protecting against flooding (Sinath).

This problem has led to serious dampening of agricultural growth. Since less than a fifth of the total cultivated land is irrigated, subsistence families have had major difficulties in controlling water resources for rice-growing purposes. As a result, the average Cambodian farm produces only 2.38 tons of rice per hectare, well below estimated production potential (“Rice Country Profile” 1). Lack of irrigation water also means that in many regions, only one rice harvest can be produced per year, creating serious food shortages two to four months of the year (Phyrun).

This poor productivity has several wide-reaching implications for the Cambodian population. The most obvious and direct effect is that subsistence families will have a lower food supply and run the risk of starving during the dry season. Poor irrigation also perpetuates poverty within poor agricultural families, because poor water management reduces crop yields, which in turn decreases the amount of surplus that can be sold for extra income. A major constraint on crop production is substantial seasonal and year - to - year differences in water availability, which severely limits the ability of rural households to consistently provide for their own food needs, much less grow crops for sale (Sinath). Poor irrigation is also detrimental to overall nutrition of Cambodian citizens in rural areas, because it prevents them from growing supplemental fruits and vegetables that would add essential vitamins and minerals to their diet. Instead, they must devote more resources on rice, which by itself is low on nutrients. The issue is compounded by drastic seasonal variation of rainfall, which makes consistency in water supply extremely difficult. In the Kampong Thom and Kampot provinces of northern Cambodia, for example, villages receive very little or no rainfall in the dry September months, and without well-developed irrigation systems, rice production is jeopardized (Thuch).

Presently, the situation is slowly improving, but is still severe and impacts all aspects of Cambodian rural life. The nation’s irrigation system has been slowly growing over the last 20 years, but remains grossly underdeveloped as compared to Vietnam and other neighboring countries (Shean). Only a small percentage of the existing irrigation structures from the Khmer Rouge can be incorporated into any effective water management system. Most structures are either completely useless or even counterproductive (Sinath). In the Tonle Sap basin alone, only 570 irrigation schemes exist, and of these 570, only 195 are fully operational (Yem 6). Taken as a whole, only 7% of irrigation schemes in Cambodia are fully functional, 34% are only “partly functional”, and the rest are nonfunctional due to lack of operation and management control.

The current irrigation problem has also led to negative developments in the Cambodian environment. First, dams build on the tributaries of the Mekong River, originally designed to regulate existing irrigation structures and to store water, have caused prolonged flooding in the surrounding lowlands. This has caused such negative effects as reduced agricultural productivity and salination of the once-fertile soil (Sinath). When excessive irrigation water evaporates, it causes accumulation of salts in the topsoil, which over time may render the soil incapable of supporting crops. In floodplain areas, many irrigation ditches have been dug toward major lake systems. They were intended to provide irrigation to surrounding farmland, but because of poor construction and engineering, the ditches now serve to drain water back into the lakes. The velocity at which the floodwater is drained causes significant soil erosion along the system (Sinath).

The need for improved water management systems is amplified by the threat of climate change caused by global warming. As shifts in global temperatures and weather systems take place, Cambodia will likely be struck hard. A study by the Cambodian Ministry of the Environment predicted that climate change may intensify the country's wet season rainfall and decrease dry season rainfall. Considering the fact that flooding accounts for 70 percent of rice paddy destruction in Cambodia, rural farmers are placed in an exceedingly vulnerable position (Sopheap). Because of this, development of effective water management and irrigation technologies is of utmost importance in ensuring the economical well being of Cambodia's rural population and adjusting to a changing climate.

### *Current Trends*

Statistics indicate that the problems associated with inadequate irrigation infrastructures are gradually being resolved, although progress is slow, difficult, and has yet to reach the poorest of the Cambodian subsistence farmers.

Rice production numbers indicate that Cambodia's agricultural sector is experiencing tremendous growth. The US Department of Agriculture (USDA) estimates that Cambodia produced a total of 4.63 million tons of rice in 2010, the country's fifth consecutive record harvest. Over the last 12 years, Cambodia's rice output has risen by 110 percent, and crop yields have grown by 40 percent. USDA officials state that one factor that led to such tremendous growth was "a considerable expansion of the nation's irrigation infrastructure" (Shean).

Improvements in irrigation are also revealed in the increase in the amount of irrigated land. According to Cambodia's Ministry of Water Resources and Meteorology, irrigated acreage in Cambodia increased by nearly 650,000 hectares, or 162 percent, between 1996 and 2007, and continue to increase today (Shean). These numbers also indicate tremendous growth in the nation's irrigation infrastructure. However, these numbers are not entirely indicative of the actual situation, as these statistics include lands in which the irrigation systems are broken and inoperable. However, as the USDA notes, "it is evident that a significant increase in overall irrigated rice acreage has occurred, and that this infrastructure has definitely contributed to the strong recent growth in national rice yields."

Despite promising trends, the irrigation crisis is still dire. 84 percent of Cambodian farmers still don't have access to adequate irrigation, and 36 percent of the population is below the poverty line. Expediting a solution to this dilemma will undoubtedly bring great benefits to the Cambodian population, in particular poor rural farmers. Expansion of an efficient irrigation network to isolated, agricultural-based

villages would generate higher rice yields and greater ability to harness wet-season rainfall for agriculture. It would also make it possible for full-irrigation farms during the dry season to become productive, thereby allowing farmers to grow year-round and avoid starvation during dry months.

#### *Possible Solutions: Gravity Irrigation Schemes and Government Regulation*

The development options for irrigation offering the greatest capacity for extensive development in Cambodia are exploitation of the copious wet season river and stream flows to provide supplementary irrigation for the wet season rice crop (Sinath). One promising program that could be implemented in Cambodia on the local level in order to take advantage of this is the gravity irrigation system. Such a structure appears to be the ideal match for the water needs and situation of the majority of poor Cambodian farmers.

Gravity irrigation systems are straightforward, basic irrigation systems that have often been overlooked as a solution to Cambodia's water management dilemma. Construction of gravity irrigation networks is simple: piping or trenches are built and connected to an uphill water reservoir. Water is then conducted from the reservoir to the piping through the force of gravity, where it can be distributed to crops (Kendzierski). Gravity irrigation systems are best used when constructed in smaller sized crop areas, such as those of most Cambodian farmers, who generally own less than 1.5 hectares of land (Kendzierski). The nation's climate is also ideal for this irrigation scheme, because gravity irrigation systems are most efficient as compared with other, more expensive types, when utilized in regions with high average precipitation and consistent rainfall (Kendzierski). Gravity irrigation structures are relatively simple to introduce at the local level and require little technical background or reliance on mechanical equipment (Sinath). For this reason, this system is perfect for subsistence farmers, as most lack the capital necessary to purchase machinery and don't have the education necessary to maintain more complex irrigation systems.

Perhaps most importantly, gravity irrigation schemes are extraordinarily inexpensive to assemble and maintain. The Irrigated Agriculture Department of Cambodia estimates that gravity irrigation only costs around 20 US dollars per hectare per year, with extremely minimal maintenance costs. This grants the Cambodian government the ability to install irrigation networks on a huge scale to even the poorest of subsistence communities, at little cost to the farmers or to the state itself. As a result, Cambodia's water management system will become consolidated across the entire country, and rice production in both the wet season and dry season will increase radically. In time, improved irrigation will allow farmers to accumulate capital and begin the process of modernizing their plots further.

In conjunction with improved irrigation systems at the local level, steps must also be taken by the national government to ensure the proper management of Cambodia's water resources. The Cambodian Ministry of Water Resources needs to establish specialized irrigation funds in order to ensure a consistent supply of monetary funds devoted to the expansion and maintenance of irrigation schemes within the country. It is also recommended that the Cambodian administration institute irrigation service centers at the local level for the purpose of supporting and providing capacity to villages (Sophanna et al.).

Efforts must also be made to connect the government with the people and provide subsistence farmers the means to independently manage their local irrigation systems. To this end, the government of Cambodia must continue to fund and expand Farmer Water Users' Community (FWUC) groups, which organize

local farmers and resources for the purpose of maintaining and developing community irrigation structures and educating farmers on proper water management (Sinath). In time, FWUCs can take complete control over their irrigation systems, which makes local development straightforward and minimizes government intervention. Currently, only about 200 FWUC groups exist in Cambodia, mostly because the government lacks the necessary capital to establish such organizations.

Because of this, non-governmental organizations such as the United Nations and the World Bank should loan money for the creation of these groups and oversee Cambodia's water management expenditures until they are self-sufficient (Sopanna et al.). Through donor assistance from external parties, the Cambodian government can continue to expand water management systems and FWUCs without the risk of accruing high national debt or running out of capital. In addition, the Cambodian government is in need of a sound, "well-defined strategy" to deal with irrigation issues. To this end, the FAO needs to step in and work with both the national government and local leaders to develop a coherent water-management plan that provides for efficient, sustainable growth (Sinath). The World Bank has also introduced the Agriculture Productivity Improvement Project, which is devoted to the development of small and medium-scale irrigation and drainage projects. Funding and expanding this operation would help FWUC groups organize more quickly and effectively and stimulate the most progress in irrigation systems in rural villages. These actions will help achieve two of Cambodia's Millennium Development Goals: to "eradicate hunger and poverty" and "ensure environmental sustainability." Improved crop yields and decreased food prices resulting from better irrigation policies will allow Cambodia to reach the goal of reducing food poverty in the country to 10% and raising national consumption to 11% by 2015. Better irrigation management and flooding control will help Cambodia reach targets in environmental protection and sustainability by 2015 as well (United Nations

### *Conclusion*

Cambodia is a land of enormous potential for economic and agricultural development. The nation has seen tremendous recovery of political stability in the last 20 years, and continues to make great progress in rebuilding its infrastructure in the wake of the Khmer Rouge regime. In short, Cambodia is a land with a dream. Unfortunately, setbacks in its water management and irrigation systems have denied many rural farmers the opportunity to improve their income and crop yields. 36 percent of Cambodians make less than .50 US dollars per day, and thousands more go hungry during the dry season. The Cambodian government has struggled to rehabilitate dysfunctional and underdeveloped irrigation patterns for lack of funding and organization. Because of this, a majority of rural Cambodians are finding it impossible to control water resources, prevent destructive flooding, and raise capital to escape poverty.

The nations of the world have an obligation to help resolve this situation, and there are several options that the Cambodian government may take to resolve the irrigation crisis. First, the government needs to invest in cheap gravity irrigation systems on a local scale. This will allow isolated villages to take control of their water for the first time and dramatically increase rice productivity. Gravity irrigation schemes work well in wet climates and require little capital to establish and maintain, making it the ideal choice of revitalizing Cambodia's weak irrigation network.

In order to pass control of irrigation systems from governmental to local institutions, the Cambodian government, with the help of NGO projects, must also expand the power and reach of FWUC organizations. Over time, these groups will have the means of maintaining and improving Cambodia's

water resource infrastructure at the village level and help farmers become self sufficient in water management.

World hunger, in Cambodia and around the globe, is not a problem that the world needs to live with. With the help of first-world nations and non-governmental organizations like the FAO and the United Nations, impoverished countries can make the dream of eradicating hunger and poverty a reality. As 2010 World Food Prize laureate Jo Luck aptly says, “It can be changed. We don’t want to just try to alleviate hunger. We want to eliminate it.”

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