Harnessing People Power for Technology Uptake

Harry Nesbitt

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Effective agricultural technology uptake depends on a continuum of knowledge within the rural community. Involving government officials, research and extension personnel, producers and consumers in the process of technology development, adaptation and evaluation is often a frustrating and slow process but it pays long-term dividends, particularly in developing countries. This paper discusses the process through which the Cambodia-IRRI-Australia Project involved its major donor, government officials, international and local institutions, non-government organizations, traders and farmers in developing technologies for rice-based farming systems in Cambodia. This successful approach re-established Cambodia as a rice-exporting nation after suffering 25 years of grain shortages. New technology is estimated to add $2.4 billion Australian to the income of rice farmers over a 30-year evaluation period.

Introduction

Effectively harnessing people power for technology uptake requires a coordinated education program crossing all sectors of the community. Such a comprehensive educational process is particularly important in developing countries where understanding the pros and cons of adopting new technology may be limited at all levels of the community from Government through to the farm level. Whereas agriculture in the Western world is a means of gaining cash income, farmers in most developing countries exist at a subsistence level, depending on their crops for home consumption and family survival. What may be small hiccups in the adoption of the latest technology in the West may well be a matter of survival for a majority of farmers in the remainder of the world, where maintaining food security is more important than increasing output at the expense of greater risk.

DR HARRY NESBITT is a consultant agronomist from Perth. He completed his honours degree in agricultural science at the University of Western Australia in 1975 and PhD on eucalypt dieback at Murdoch in 1979. After developing agronomic expertise with private companies and on development projects in the Philippines and Thailand, he took up a position with the Cambodia-IRRI-Australia Project (CIAP) in Phnom Penh. He was the Agronomist/Team leader of CIAP for thirteen years concluding in 2001; in this period AusAID and IRRI invested $20 million in developing the capacity of Cambodian Ministry of Agriculture personnel to adapt and extend technologies to improve productivity of rice-based farming systems. Farmers are expected to obtain over $2.4 billion worth of extra rice production over a 30-year period.

In addition, it may not be possible for some farmers to take advantage of the latest developments in biotechnology until they have their farming basics properly in place. Ensuring the fields are properly prepared, drained, watered, fertilized and maintained pest free, and that grain is harvested and stored in a timely manner, is a challenge for all farmers, particularly in developing countries. More importantly, a farming systems approach should be taken to guard against increasing yield from one component at the cost of overall farm production.

In some countries, the capacity to both develop and transfer applied technologies may be at a rudimentary level. Subsequently it may be necessary to upgrade the technology development and transfer system as a whole in order to achieve a measurable impact. In the following paper, an experience in Cambodia is used to illustrate how this can be achieved at small cost when good coordination exists between international and local organizations, and the farming community.

Context and rationale of project in Cambodia

Cambodia was a major rice-exporting nation in the 1960s as the yields and area under crop slowly increased following independence from the French in 1953 (Helmers 1996; Nesbitt 1996). In 1964/65 rice exports exceeded 500 000 t yr^{-1} and Cambodia was considered to be a rice bowl of SE Asia. Its capital, Phnom Penh, was also a cultural magnet with the population enjoying a good quality of life. This encouraging production trend soon reversed itself as the country became increasingly embroiled in the war against communism. By 1975, when Phnom Penh finally fell to the communist Khmer Rouge, the area under rice had declined by 77% and rice production had decreased by 84% of the 1970 level. During the Pol Pot (Khmer Rouge) era (1975-79) the country was further devastated through mass dislocation of the population. Intellectuals were persecuted and 25% of the population perished. By 1980 there was a dire shortage of qualified personnel remaining to help rejuvenate the shattered economy. Only 40 of the 400 pre-war-qualified agriculturalists remained in the country at this time, and most of the research infrastructure had been destroyed. Cambodia faced annual rice shortfalls ranging between 50 000 and 200 000 tons during the 1980s. The green revolution had virtually passed by Cambodia and its farmers continued to use traditional practices, many of which had been in operation for over a thousand years. To make matters worse, the Pol Pot policy of dislocating the farmers from their accustomed ecosystems resulted in many of the traditional rice varieties being lost. Cambodian farmers desperately needed access to improved technologies. There were, however, few technicians capable of developing or adapting higher-yielding practices for Cambodian conditions, a national technology evaluation system was non-existent and agricultural extension was under-resourced. The Cambodian Ministry of Agriculture Forestry and Fisheries (MAFF) turned to the International Rice Research Institute (IRRI) for assistance in 1986, and by 1987 an agreement had been formulated between the Australian Government and IRRI to address rice production problems in Indochina (IRRI 1988). IRRI accepted its first Cambodian agriculturalists for rice production courses in 1987 and an IRRI representative was assigned to reside in-country the following year to set up a national agricultural research system which was designed to include components of human resources enhancement and technology development (IRRI 1990). The goal of the project, soon to be known as the Cambodia-IRRI-Australia Project was 'To increase rice production and the productivity of rice-based whole farm production systems in Cambodia'. Its objectives were:

a) To enhance the capacity in Cambodia to develop technologies in support of rice-based farming systems;
b) Improvement of the quality and quantity of research conducted in rice-based farming systems to improve household food and income security; and
c) Development of a research system and the capacity of the system to conduct and manage agricultural research and training.

Over the following years, the project design included components of technology development, farming systems and the development of a research system. Each component possessed a number of sub-components.

Technology development included plant varietal improvement, integrated nutrient management, integrated pest management and agricultural engineering. Farming systems included an understanding of the system (with social sciences), development of farming system methodology within the research fraternity and a component of on-farm agronomic diversification. Re-establishing a research system in Cambodia after years of neglect and destruction required concentrated effort on developing human resources capable of conducting and managing a research program, on the development of the system itself and rehabilitation of sufficient infrastructure capable of supporting the programs.

The project was directed by its main sponsor, AusAID, to be cost effective and was asked to develop an efficient management system which possessed an appropriate level of gender sensitivity, used a collaborative approach, was environmentally conscious and had an effective monitoring and evaluation system. Most project activities were conducted over a thirteen-year period from the beginning of 1989, although a small number of training courses and diagnostic surveys were conducted prior to that year. About US$24.65 million was invested in the project. These funds were well spent, as the project outputs and impact were considerable (Norris 2000; Raab 2000; Norris *et al*. 2001; Urwin and Wrigley 2001; Young *et al*. 2001).

Major project outputs

1. Technology development

Plant varietal improvement

At the commencement of the project, IRRI plant breeders were aware that Cambodia still possessed a wide diversity of genetic material in the countryside, particularly within the rice population. To conserve this diversity, rice germplasm was collected over a five-year period from 1989, resulting in 2500 varieties being stored in Cambodia with duplicates at the rice gene bank in the Philippines. A collection of 500 accessions stored earlier in the Philippines was returned to Cambodia in 1988. Some varieties, lost during the war, were returned to farmers. Four single-line isolates were developed from the collection and released as high-yielding traditional rice varieties. A total of 34 photo-period-sensitive and non-photoperiod-sensitive varieties were released before the project terminated at the end of 2001. By this stage, a viable seed production system had been established in collaboration with other organizations.

Integrated nutrient management

A soil classification system developed in the 1950s by a USAID soil scientist (Crocker 1962) was initially used by scientists in Cambodia to formulate soil improvement recommendations. This pedological system soon proved to be inadequate and an in-house agronomic soil classification system was developed and used to formulate soil improvement recommendations for the major rice-growing soils. The soils were then mapped to assist identification of factors limiting rice production and for the establishment of policies for the sustainable farming of each soil type (White *et al*. 1997).

Integrated pest management

Surveys conducted during the 1980s indicated that pests were not a major problem in Cambodian rice fields. This appeared to be an ideal opportunity for the introduction of integrated pest management techniques before pest incidence increased. AusAID was brave enough to support the implementation of such a program, and an IPM team was assigned to the project in 1995. By the end of 2001, IPM techniques were developed and recommended for 11 key pests, a museum of insect, weed, rodent and snail pests was established, pest distribution maps were developed and a national pest forecasting program was established. Participatory rodent control methods and a golden apple snail eradication program were also in operation.

Agricultural engineering

The agricultural engineering team extended improved on-farm water harvesting techniques, in addition to developing labor-efficient crop establishment techniques and post-harvest improvements.

2. Farming systems

The integration of each of the above technologies into productivity-improving systems was achieved only after a number of baseline surveys and in-depth studies of household consumption and income were completed. A system was also developed to incorporate Government, Projects, NGOs and other agents of extension into the research process. Much of this research was conducted in a participatory manner with extension agents.

Agronomic diversification was promoted after collaborative work with the Asian Institute of Technology (AIT) and the Cambodia-Australia Agricultural Extension Project (CAAEP) developed manuals for rice fisheries and animals in the rice ecosystem to encourage agricultural diversity under challenging conditions (Gregory 1997; McLean 1999).

3. Development of the research system

Human resources development

Training needs were regularly assessed during the project, and revised as the capacity for research and extension improved. Short courses were provided directly by project personnel and through qualified agencies within the country. Short-, medium- and long-term training was also provided abroad. As a result, between 1987 and 2001, over 7000 training opportunities were provided to more than 1700 individuals. Twelve PhD graduates from Australian universities now lead the agricultural research system in Cambodia.

System development

By the end of the project, a national agricultural research system was established, directed by the newly-established Cambodian Agricultural Research and Development Institute (CARDI), and operating through MAFF technical sections and provincial agricultural offices.

Infrastructure

Almost all research facilities were completely destroyed between 1975 and 1979 during implementation of the 'year zero' policies of the Khmer Rouge. It was not until CIAP established an office in Cambodia in 1988 that support for research infrastructure rehabilitation was forthcoming. Buildings were constructed on 14 research stations across 9 provinces, and assistance was provided to stock the buildings with basic research essentials. Land for establishment of CARDI was allocated by the Cambodian Government in 2000, and funds were allocated by the Australian and USA Governments for construction of buildings and the provision of equipment. CARDI assumed responsibility of agronomic research at the end of 2001.

Project impact

Towards the end of the life of CIAP (at the end of 2001) five impact studies were conducted to determine the effect of the project on Cambodian agriculture. The studies included evaluations of human resources development and information dissemination, the interactions of CIAP with the NGO community, environmental impacts, gender, and finally the impact of the project on the Cambodian economy.

1. Human resources development and information dissemination

The large number of training opportunities (over 7000) provided by the project had an extremely strong impact on the technical personnel within the MAFF. This knowledge capital, widely acknowledged by the UN, NGOs, government officers and private enterprise, provided the basis for most training courses for farmers held in Cambodia during the 1990s. The project also provided reference material from its library, a pest management laboratory, a soils laboratory, and plant breeding and engineering offices.

2. CIAP – NGO interactions

CIAP had a very strong impact on the institutional capacity of NGOs by training Cambodian NGO staff members, the formation of a technical group responsible for information dissemination (resulting in the formation of the Cambodian Society of Agriculture) and through extensive technical backstopping. NGOs played a key role in disseminating and adapting CIAP technology for use by farmers. NGOs had vital access to farmers problems at the grassroots level, and they provided feedback to CIAP on the requirements for research.

3. Environment

As far as the Environmental Impact Assessment team could determine, the main threat of environmental degradation by CIAP on Cambodian agriculture was the loss of genetic diversity of rice in Cambodia because of rapid adoption of project-released varieties. In addition, the reviewers considered that farmers could over-use or misuse of fertilizers, resulting in the contamination of ground and surface water supplies. Conservation of Cambodian rice was a concern for all project personnel because they could foresee Cambodia adopting a smaller number of higher-yielding rices and losing the diverse range of traditional types. Project plant breeders placed considerable emphasis on collecting a complete set of Cambodian rice varieties for long-term storage in the event of this happening. The agronomic soil classification system also allowed targeted fertilizer recommendations, thereby reducing pollution of ground and surface water sources. It was also considered that the pre-emptive IPM program reduced the adoption and use of pesticides. Other project recommendations improved agro-diversity, increased fish numbers in the paddies and reduced greenhouse gasses.

4. Gender

Demand for women's labour increased when farms adopted CIAP's high-yielding rice varieties (HYV) and improved single-line isolates of traditional rice (CAR) varieties. More work was also involved with extra fertilizer applications, improved seed storage techniques and knowledge-intensive activities like IPM. Demand for women's labour was decreased by land leveling and direct seeding. Conversely, farm diversification recommendations hold tremendous potential for improving the economies of female-headed households.

Agriculture was generally not the first choice for women to study in Cambodia, and there was never a high proportion of women among technicians employed by government and non-government organizations. Despite this, rates of participation by women in CIAP courses were well above Government ratios, and the project personnel list reflected higher ratios of women workers than did that of the Government.

5. Economic impact

Rice production in Cambodia increased by 50% over the length of the project, mainly due to the adoption by farmers of technology recommended by CIAP. The extra production resulted in estimated net financial benefits to Cambodian farmers of US$1.3 billion. An economic rate of return of 32% for the full life (1997-2020) of the project evaluation period was calculated for the rice production component. Included in the calculation were investment costs for research and development, extension and on-farm investment. Operating costs included those for dry season, early wet season and main crop production. Extra animal production and improved population health benefits were not included in this calculation. Most importantly, the project achieved its goal of developing technologies from which all Cambodian farmers could potentially benefit. New technologies continue to be developed at the newly-established CARDI, and further improvements to agricultural productivity are forthcoming.

Sustainability

CIAP's goal of increased agricultural production and productivity was achieved after improved technologies were released to and utilized by the farming community. This resulted in Cambodia becoming self-sufficient in rice production by 1995, and the country has exported rice each year since then. A vast improvement has already been made to food security in a major proportion of Cambodian farm households. Sustaining project gains over the medium and long term is dependent on a number of factors. These are described below.

Human resource development, retention of expertise and attraction to research

An impact study on the development of human capital in CIAP (Raab 2000), conducted in 2000, considered that the 1800 persons trained over the length of the project will continue to have an impact on technology development well into the 21st century. This will result from the extension of existing or the development of new technologies. Personnel trained in the early years of the project now hold senior positions in provincial and central government offices and use their knowledge to train younger staff members. The multiplier effect is considered to be six-fold, dramatically expanding the effects of the training.

All CIAP-trained personnel remain in Cambodia, supporting the development of agriculture. Some personnel have shifted focus from research to extension or development work, but directly or indirectly they still assist the spread of CIAP-developed technologies. Replacement of this expertise and attraction of researchers to CARDI will be assisted by a new project to support CARDI management (CARDIAP) funded by AusAID, funds from an ADB loan and funds from CARDI income-generation projects. An important component of these projects will remain supplements to the low government salaries to attract and retain staff possessing a high degree of research expertise.

Technology development

Technology developed by CIAP has now increased the production and productivity of rice-based farming systems by more than A$100 million per year, and this benefit will grow as the technology is extended to more farmers. The gains made to date will never be lost. Refinement of these technologies and development of new technologies will be made through the now-existing national agricultural research system with CARDI as its headquarters.

Extension

An efficient knowledge delivery system is a key to the success of an agricultural research system. Fortunately for CARDI, the establishment of the Department of Agricultural Extension, and projects to support it, ensure that technologies developed by CIAP and CARDI will effectively reach the farmers. CAAEP and the Agricultural Quality Improvement Project (AQIP), both AusAID-funded projects, remain lead agencies in agricultural extension, seed production and post-harvest quality control.

Environmental and economic sustainability of technologies

A conscious effort was made to ensure that project-developed technologies were environmentally and economically sustainable before being released to stakeholders. Initially, for example, the nutrient recycling work relied on the use of locally-available inputs such as green manures, farm-yard manure and applications of rock phosphate. When the markets opened up and chemical fertilizers became available, soil improvement recommendations were expanded to cater for a wider range of social groups. Recommendations remained targeted to soil type and are therefore sustainable in an environmental sense. More laborious but less expensive technologies remained a core of the recommendation schedule for poorer farmers. The same principles were applied to the range of varieties offered and to recommendations for water security, agronomy and IPM.

Germplasm conservation

The range of rice varieties available in the farming community will diminish as CIAP-recommended varieties spread onto a larger number of farms. Loss of this germplasm is protected through the existence of a germplasm centre at CARDI. The collection is stored in a number of low-cost domestic freezers which are easy to maintain and do not require a constant supply of electricity. Thus the collection is reasonably secure. To be doubly sure, a duplicate set of varieties is kept in long-term storage facilities at IRRI headquarters in the Philippines.

Seed production

Ongoing supplies of seed of CIAP-released varieties are essential to ensure sustainability of project benefits. This seed production may become the responsibility of commercial seed producers, leaving research institutions free to develop new varieties.

Infrastructure

Research infrastructure

All buildings constructed by CIAP at CARDI and on provincial research stations were designed to operate with minimum overhead. Offices at CARDI, for example, with high ceilings, can be cooled using fans with electricity provided by a small generator rather than cooled by more expensive air conditioners. Farm operations on all stations can also be conducted with local methods on small budgets. Extra construction at CARDI is planned under an ADB-funded project. In general, sustainability of the research system in not a problem if government personnel remain interested in developing technologies and operational funding continues to be forthcoming from both Government and non-government sources.

National infrastructure

The export of farm produce relies on maintenance of rural infrastructure. This responsibility is assumed by provincial and national, non-research authorities.

Finances

CARDI cannot survive on government funding alone, but its financial security is assured for at least the next five years. Support is being provided by ADB for infrastructure, research and general operating costs, and the Government provides government-level salaries as well as some funds for research and operating costs. AusAID will assist with salary support, management training and some research costs, while CARDI will generate additional funds through the business unit. Planned income-generating activities include seed production, contract research, training and personnel services. Smaller sources of funds include collaborative research programs with institutes and projects. Included in this category are activities with UN agencies, international organizations including IRRI, bi- and multi-lateral aid programs, and ACIAR.

Farmers also require improved access to affordable credit to facilitate the purchase of farm inputs and allow the family to pay for unexpected expenses including family health bills. A number of micro-credit facilities have opened up in rural areas in the past few years, reducing the cost of borrowing for poor farmers and thereby improving the chances of farmers adopting more profitable modern farming practices.

Local and overseas technical support

CARDI will need to maintain strong linkages with local and overseas organizations to retain an up-to-date and focused research program. It already has collaborative projects with UN agencies, NGOs, bi- and multi-lateral aid agencies in Cambodia, and projects with ACIAR, IRRI and the Asian Vegetable Research and Development Center (AVRDC). Technical support from these organizations will provide good support for specific research projects, but will need to be carefully managed by CARDI to ensure that the research program does not become too fragmented and donor driven. IRRI will open an office at CARDI to maintain close collaboration between the two organizations.

Research priority setting to maintain relevance

Setting relevant research priorities is a constant challenge for all research institutes, and particularly those with limited resources. CARDI will need to strike a balance between complying with Government directions, generating income and satisfying donors.

Capacity to respond

Maintaining research relevance will require CARDI to continue to respond to the changing environment. This process will be assisted by maintaining a flexible personnel management system, allowing staff to transfer between internal and external projects. Any reduction in the capacity to respond will make it difficult for CARDI to maintain relevant research.

Political awareness

CARDI has maintained a particularly high level of political awareness since its inception in 1988. During his speech at the institute's inauguration ceremony and on other occasions, the Prime Minister promised not to neglect his 'baby', thereby ensuring the long-term sustainability of institute.

Lessons learned

AusAID personnel envisaged the establishment of the research sector in Cambodia as being a long-term process and planned assistance accordingly. This was a thoughtful approach and an important lesson when designing similar projects for other developing countries. The fielding of expatriate personnel for long periods also provided continuity for Cambodian counterparts.

A comprehensive human resources development program was necessary to establish an efficient R&D system in Cambodia. A conduit was required through which technology could reach the farmer, and for those involved to be sufficiently motivated to gather feedback on the suitability of technology in the field. It was widely acknowledged by project staff and external observers that the collaborative approach to R&D by CIAP and partners was a key factor in the success of the project. Without the effort of the UN, NGO, multi- and bi-lateral aid projects and Government organizations working closely with CIAP personnel, the technology would not have reached the farmers. The project promoted this collaboration by organizing technical groups and facilitating training programs.

It was necessary to implement only a low level of technology to significantly improve the productivity of rice crops in Cambodia. There is still considerable latitude before farmers' yields approach the crop's potential in each of the ecosystems. The key is transferring knowledge to farmers and for researchers to develop the tools to facilitate that transfer.

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