



CAMBODIA'S JOURNEY

When Australian agronomist Harry Nesbitt first trod Phnom Penh's deserted smoke-blackened streets in 1988, the task of re-establishing a whole country's ability to feed itself seemed hopeless.

Responding to an urgent summons from IRRI and AusAID he found almost all knowledge of traditional rice farming practices had been lost – varieties and their traits, soil characteristics, irrigation and drainage, plant breeding, cultivation, and pest management.

The country's trained agriculturalists had either been murdered or forced to flee, and farmers had been relocated to work unfamiliar soils and terrain.

Nesbitt's first priority was to prevent a famine. His next was to rebuild a system of national agricultural

research; a program that eventually was formalised as CIAP – the Cambodia-IRRI-Australia Project.

Today CIAP has made way for CARDI – the Cambodian Agricultural Research and Development Institute – and the research targets have broadened considerably from food security to the development of diverse, high-production agriculture.

There is still an enormous distance to travel, but the journey towards modern agriculture that barely seemed thinkable a decade ago, is now under way in earnest.

On pages 4-10, BRAD COLLIS reports on some of the ACIAR projects that are helping to transform the focus of Cambodian farming from rice-based food security to a diverse agricultural economy.



RESEARCH FEEDS A NATION'S FUTURE

ACIAR is playing an important role in this new stage of Cambodia's agricultural development, supporting key areas of research into new crops for more diverse and intensive farming systems, improved animal health as livestock production begins to lift, and in the staple area of rice – improved quality and production systems with an eye to future exports.

“We are moving from one crop, rice, to a variety of fruits, vegetables and crops such as maize and chilli,” explains CARDI's inaugural director, Dr Men Sarom.

“Food security is still important and still needs ongoing research, but our mandate has been broadened to also look at ways to improve living standards by developing crops that can compete for quality against imports,” he says.

Dr Sarom says CARDI and its basic research is crucial if Cambodian farmers are to have ongoing technical support, and if agriculture is to play the role it needs to play in making rural communities more secure economically and socially.

“To do this, research has to be provided for every part of the country. There are still large areas that are missing out because we don't have the scientific resources,” he says.

“So support from agencies like ACIAR remains critical. Yes, we have come a long way, and some say it is time to stand on our own feet – but really we are still laying our foundations.”

Dr Sarom also says there is a rapidly emerging need to match higher yields and higher quality produce, with avenues and infrastructure for marketing: “Farmers are seeing yields and quality rising, and are now asking how they are going to sell this improved production.”

Dr Sarom hopes part of the answer will be found in CARDI's newly established business unit. However, he believes the long-term answer to marrying improved production with a market economy will be the intervention of a third-party trading house; a specialist marketing body. Even though this development is still somewhere in the future, the fact it is even now on the agenda is testimony to the progress being made at the farm and village level.

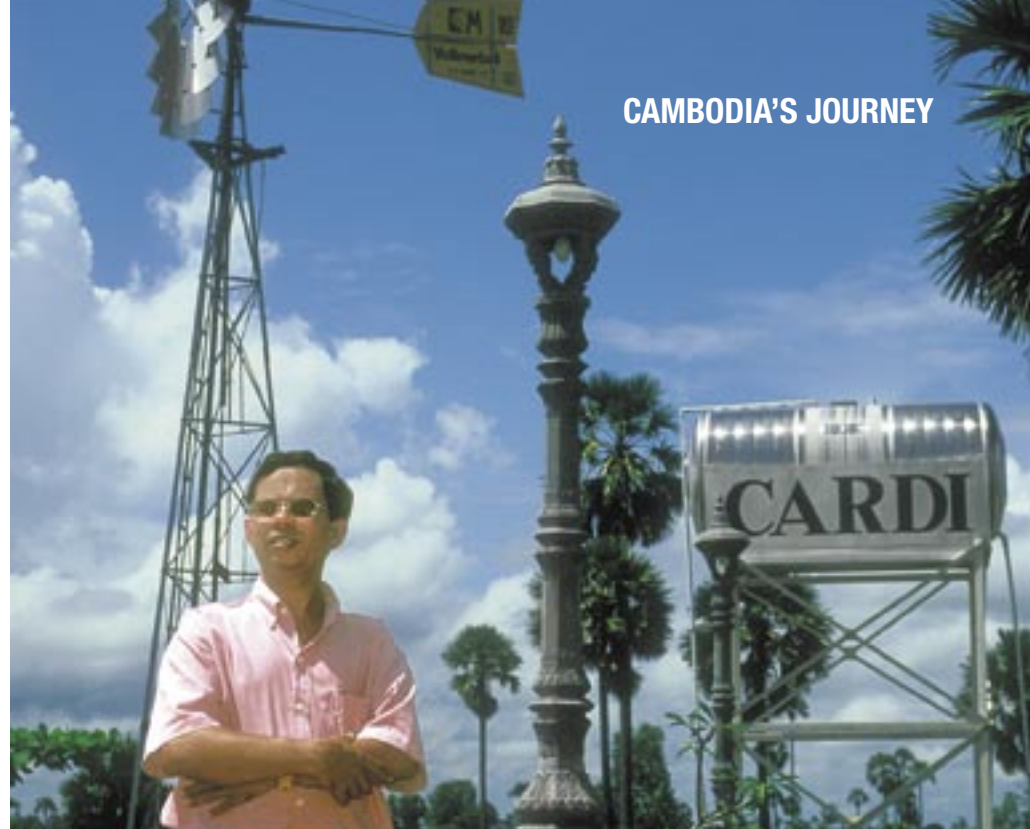
Project leader of ACIAR's crop diversification program is CARDI's deputy director, Ms Chan Phaloeun, who with Men Sarom was one of Harry Nesbitt's early protégés.

Phaloeun says CARDI's three priorities are:

- A Cambodian Government policy to raise local rice varieties to export quality;
- Development of legumes and maize; and
- Horticulture.

“While there has been progress, our farmers are still very poor so our charter to diminish poverty remains the primary objective,” she says. “However, we also need to stimulate socio-economic growth.”

Phaloeun says the crop diversification project is ►



Improving systems: director of CARDI, Dr Men Sarom.

► specifically targeting upland areas that grow rainfed rice and cash crops. These areas missed the first wave of research during the CIAP period which was aimed at helping the traditional lowland rice areas to simply feed everyone.

(The research priority in the irrigated lowland regions is intensification rather than diversification.)

The upland diversification project's first stage has been a survey of existing systems, soils and agronomy. The survey, and the first trials, have been in the Batdambang and Kampong Cham provinces where soils range from very poor through to highly fertile, and where there is some diversification already with rubber and peanuts.

"We need to learn what else these different upland soils can sustain, in particular crops that can be grown in rotation with rainfed rice.

"As a country we are looking to reduce our reliance on rice, but for farmers this reliance is still very strong. Even though non-rice crops will earn more than rice, farmers prefer rice because (a) they know it, (b) the seed keeps for a long time so it offers security and (c) it is their staple diet."

Phaloeun believes there is considerable potential in the uplands for farmers to grow two crops a year without irrigation, but a lot of work needs to be done on basics such as time of planting, appropriate varieties, and pest and disease control.

"Cambodian farmers are still nervous about change and need to see results before taking a risk."

Joint project leader, Dr Bob Martin from NSW Agriculture says the upland diversification project is concentrating on six crops – corn, soybean, mungbean, peanuts, sesame and cowpea.

"The aim is to improve farmers' cash incomes, as well as to provide a better variety of food in people's diets," he says. "We began by looking at the issues that might hinder this, such as soils and lack of suitable varieties, and we are now confident that we have identified a good mix of suitable crops. We've brought in varieties from Thailand and Australia, and these have been introduced into CARDI's breeding programs.

"Now we are ready to tackle some basic agronomy – crop rotations, the management of pests and diseases, whether or not upland legume crops do provide nitrogen for subsequent non-legume crops.

"In the next full season of work we will also look at whether or not these legumes need rhizobial inoculation, and also techniques for improving soil moisture retention.

"Just as happened in Australia, farmers plough after the first rain, which means most of the moisture is immediately lost, and they then have to wait for the follow-up rain before planting the crop.

"So we are going to look at improving soil moisture management through minimum tillage and stubble retention as a way of allowing farmers to sow much earlier. Sowing earlier

would see them get the crop through before the main flush of insects."

The crop diversification project is now working hand-in-glove with the land suitability/soils assessment project under associate professor Richard Bell from Murdoch University.

Professor Bell, working with Dr Peter White from the Department of Agriculture in WA and CARDI's Dr Seng Vang, is assessing upland soil types for non-rice crops.

He says the catalyst for now turning to crop diversification is that Cambodia has now been self-sufficient in rice, at a national level, for several years.

"Lowland rice is the dominant subsistence crop for most rural households, however diversification can be achieved by growing field crops either before or after growing rice," he says. "In addition there is substantial untapped potential to expand the production of field crops such as maize, soybean, mung bean, peanut and sesame in the uplands where a lot of land is unsuited to rice.

"We will conduct detailed studies in a single district in ►



Diversification: CARDI deputy director Chan Phaloeun (right) meets with farmers to discuss their changing needs.



Focusing on five crops:

Dr Seng Vang, head of CARDI's soil and water sciences program.

finding crops that can be grown during this period, there is also a potential sociological hurdle – introducing an additional cropping regime to the village calendar.

“Finding the crops might be the easy part. The main task will be to match this with farmers’ capacity to change,” says Dr Vang. “Also,

if we are to introduce another crop outside the annual rice crop it will have to be highly marketable. No matter how successfully they might grow new crops, if they can't sell them they will revert immediately to their basic crops.

“Marketing support is going to be as important as technical support.”

Dr Vang says that while there are always ‘early adopters’ the introduction of a new, diverse, cropping system will be difficult for most farmers, especially if it involves investment and risk.

He says farmers have shown they can be very receptive to change, but the benefits have to be demonstrated first: “We will have to make sure that all the factors that farmers can control, such as choice of variety, time of planting, are right, before they are going to take the next step and spend money on fertilisers.

“In the lowlands you can make a mistake, but still get a rice crop. In the uplands, a mistake means you get nothing, so food security is still the main issue.”

This quest to increase the adoption of crop diversification in Cambodia also has a twin project running in Western Australia. In Cambodia, the project is assessing land suitability for non-rice crops. In WA, the project is assessing land suitability for pulse cropping under a range of production scenarios.

While there are clear differences between the rice-based agriculture of monsoonal Cambodia, and the wheat-based agriculture of Mediterranean southwest Australia, there are significant common interests. Agriculture is dominated by a single cereal crop in each case, and while diversification opportunities appear to exist, there are key blockages in adoption.

The underlying premise of the project is that a more explicit description of the limiting biophysical and socio-economic factors will help to improve adoption of crop diversification in both countries.

► each of three key provinces – Takeo on predominantly sandy soils, in Kampong Cham on basaltic soils, and in Batdambang on mixed geology.”

Professor Bell says the variety of soils in each district will be described and mapped, with Noel Schoknecht of the WA Department of Agriculture providing the key technical input.

For each of the soils, key limiting factors will be identified and rated in severity to determine the capability of the land for field crops. Apart from the soil survey the team will also use on-farm experiments and interviews with farmers and local agriculturalists.

“Land capability is an assessment of the biophysical resource and its potential for sustainable use. However, socio-economic factors also need to be considered in determining the most suitable use of the land,” says Professor Bell. “So we will examine socio-economic factors such as market accessibility for field crops based on road condition and distance to markets.”

Dr Vang, head of CARDI's soil and water sciences program, says the land suitability project is focusing on five crops – maize (corn), mungbean, soybean, sesame and peanuts.

He explains that because the upland regions have always relied on rainfed rice, these areas should be more conducive to crops such as these. “And we are looking at ways to increase production in relation to water availability and soil constraints,” he says.

The main soil constraints are deficiencies in nitrogen, phosphorus and in some areas, iron.

Upland areas essentially have three seasons – early wet season, main wet season and the dry season. Agronomists believe there is potential to add crops to the early wet season, when the rainfall is traditionally too unreliable for rice, but may be enough for less thirsty crops.

However, Dr Vang says that in addition to

PROJECTS:

ASEM/2000/109 Farming systems research for crop diversification in Cambodia and Australia

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LWR/2001/051 Assessing land suitability for crop diversification in Cambodia and Australia

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ACIAR'S KEY ROLE

ACIAR's recent role in helping Cambodia expand and diversify its agricultural sector continues Australia's development assistance, which played a key role in the country's return to self-sufficiency.

In 1986 scientists from the International Rice Research Institute (IRRI) visited Cambodia to assess research and training needs. The Australian Government, through AusAID, responded by funding initial studies that helped establish the Cambodia-IRRI-Australia Project (CIAP).

CIAP, by placing Australian and international agronomists in-country, lifted Cambodia's rice productivity, achieving self-sufficiency in 1995. Since that time the focus of international development assistance has been on developing more sustainable whole-farm production systems, including diversifying production beyond rice.

ACIAR's strategy in Cambodia is to support research that underpins this diversification, while also increasing the productivity of rice-based farming systems. Rice remains both the staple food crop and the basis of food security for much of Cambodia.

Cambodian farming is still largely based on rice systems of relatively low productivity.

Increasing the security and income that rice offers farmers, helps enable them to invest in more diversified agricultural activities. Increased productivity also frees up land from rice cultivation. ACIAR's suite of current and pipeline projects targets rice productivity, as well as corresponding areas of research that support agricultural diversification.

Projects currently underway include developing the basis for improved livestock productivity through addressing animal diseases, including through projects in neighbouring countries, aquaculture for smallholder farmers and improvements in marketing systems for non-rice crops.

All of these projects have, as a central role, the building of Cambodian scientific expertise and capacity. Scientific capacity also continues to be restored through the AusAID-funded



Cambodian Agricultural Research and Development Institute Assistance Project, of which ACIAR is managing a component.

The Cambodian Agricultural Research Fund is helping to establish a competitive research sector through provision of competitive tendering for agricultural research.

Successful applicants receive training to undertake research problem identification, preparation of proposals and report writing necessary to interact with the international scientific community and donors.

ACIAR has also linked several of its research projects to AusAID-supported extension, industry development and institutional capacity-building initiatives.

Beyond rice: a Cambodian farmer contemplates a future that is now stretching from subsistence to sustenance to enterprise.



MULTI-LEVEL APPROACH TO STRATEGIC RICE BREEDING

Search for quality: CARDI research assistant Then Rothmny oversees rice seed being planted as part of a breeding program to lift the quality of Cambodian rice.

A key plank in the platform Cambodia is building for a more commercial agricultural sector is the ACIAR-supported project to increase production in the core rice-based cropping systems.

A multi-level approach is being taken to develop more efficient breeding strategies, and to use these to speed up the development of important advances such as drought-tolerant rice varieties, and to develop the right agronomy for other crops such as mungbeans to be grown in rotation with rainfed lowland rice.

The project is also trying to resolve the issue of whether or not farmers should direct seed, or transplant seedlings. Farmers are divided, but the research so far is not finding a strong case to support one method against the other.

The efforts at CARDI to increase production in its rice-based systems are part of a wider project with similar goals in Lao PDR and Australia.

Project researcher in Cambodia, Dr Makara Ouk, has been concentrating on developing a more efficient plant breeding program by eliminating unnecessary trial locations and years, before a breeding program begins.

“We started out with the question: ‘Do we need to test in so many locations, and over how many years do we need

to test to determine the selections for a breeding program?’” he explains.

After three years studying 34 genotypes from various sources in multiple locations, Dr Ouk says his team has concluded that a reliable starting point for breeding requires no more than eight multi-location trials in order to select enough broadly adapted cultivars.

Further, he says they have shown that these pre-emptive trials need only run for two years.

This represents a significant reduction in the preparatory work needed for selecting cultivars for breeding programs.

Dr Ouk says that if there is a business side to plant breeding in a developing country, then it is to minimise the work and to maximise the results of that work.

This strategy for selecting broadly adaptive cultivars now forms the basis of all of CARDI’s breeding programs – including the search for drought-tolerant rice varieties.

Drought-resistant lines identified in these projects are being used as donors for new populations that will help the development of agronomically acceptable, and widely adaptable, cultivars.

Dr Ouk says five genotypes have so far been identified as having the potential to develop into drought-tolerant varieties.

An interesting aspect of the research has been the development of a method of simulating late season drought conditions in the wet season for plant selection. ▶



Efficient testing: project researcher Dr Makara Ouk.

PROJECT:

CIM/1999/048 Increased productivity of rice-based cropping systems in Lao PDR, Cambodia and Australia

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KNOWLEDGE BRINGS NEW HOPE

Developed in Thailand by the ACIAR project, and adapted by researchers in most countries in South-East Asia, the procedure is to drain paddies during the reproductive phase of growth and then to keep the soil dry.

Using this technique, the CARDI researchers are looking for traits that can be related to drought tolerance – such as delayed flowering, phenology, drought response index and leaf water potential. Under drought conditions some genotypes are known to transpire more slowly.

A third component of the project has been to try and resolve the arguments over whether direct seeding or seedling transplanting produces better yields.

Research over the past three years has not found one method to be better than the other, although some genotypes, when direct seeded, suffer yield losses through lodging.

Dr Ouk says these genotypes have been observed to develop narrower and taller stems under direct seeding, but he says it is an observation that has yet to be tested.

However, aside from the yields debate, it has been shown elsewhere that direct seeding can shorten the planting time and reduce labour needs for transplanting.

A direct seeding experiment at Savannakhet in Laos showed that higher seed rate (200 kilograms per hectare) in broadcasting could produce higher grain yield than lower seed rates. However, it appears this can be offset by higher seed rates leading to small seed.

and suitability trials in the Kampong Cham province are covering both rainfed upland and lowland systems, with a view to identifying a wider range of crops that will maintain food security while increasing household incomes.

Mr Katam Sonavann, chief of Agronomy and Agricultural Land Improvement in Cambodia's Ministry of Agriculture Forestry and Fisheries' Kampong Cham office, says farmers are eager for knowledge and for more choice, but have not had the necessary technical support.

He says there is now a lot of hope that trials with mungbeans, corn, sesame and peanuts will help to lift, and diversify, production – and break farmers free from their traditional subsistence culture.

The trials are not only exploring the range of crops, but are also measuring the effects of fertiliser, and improved nitrogen fixation by soybeans when the soil is first inoculated with nitrogen-fixing rhizobia bacteria. Cambodia's soils lack natural soil rhizobia.

A leading farmer in one village that is hosting ACIAR-supported trials, Mr Long Chhem, says he and his neighbours are putting considerable hope

Wanting support:

Mr Katam Sonavann, chief of the Agronomy and Agricultural Land Improvement Office at Kampong Cham province, says farmers are eager for knowledge.

in the research that is taking place.

This has a lot to do with the massive increases in rice yields that the farmers have enjoyed since adopting, after a protracted village debate, the modern rice variety IR66.

The villagers resisted the variety for years, out of fear of change. When finally they took the plunge, the new high-yielding variety changed their lives. They have similar hopes for some of the new crops, although researchers and extension officers have tried to temper their expectations.

Mr Chhem says the villagers do realise that

the returns they are getting from the experimental crops won't necessarily be achieved by farmers, especially since the researchers are using fertiliser.

The villagers are still nervous about the cost of fertiliser and are still waiting to be convinced that their returns will repay the investment.

But generally, Mr Chhem says the village's experience with IR66 has made them value knowledge: "We know that if our knowledge is increased, then eventually our prosperity will also increase," he says.

The same sentiment is echoed down the hill in a lowland farming system in the village of Tuol Thkov, where farmer Mr UI Seang says the sole reason he has allowed some of his land to be used for trials is because of the knowledge he will gain from his involvement.

"Before, I knew nothing about fertilisers. Now I am starting to understand and I can see the results," he says.

Mr Seang says that as soon as the project establishes just what crop options the district has, his ambition is to progress from one rice crop a year to a rotation of two or three different crops.



Trapping success: farmers using the trap barrier system are not only reporting fewer rats but also yield increases of up to 70 percent.
Inset photo: CSIRO

GOOD NEIGHBOURS KEY TO WAR ON RATS

Building on previous ACIAR work on rodent control in South-East Asia, the 'farmer-based rodent management' project in Cambodia has been achieving some spectacular results in village trials. The 'trap barrier system' (TBS) that lures and captures rats from the surrounding countryside before the main rice crops mature, is highlighting the scale of the rat problem and the significant yield lifts that are possible when rat numbers are reduced.

Under the system, a small rice crop – about 25 metres square – is sown early and inside a low plastic fence, or barrier, that is surrounded by a water filled moat. Submerged earthen 'bridges' in the moat lead to gaps in the fence, which are entrances to multiple-capture live rat traps.

The system works by exploiting the link between the growth of the rice crop and the breeding biology of the two ricefield rats (*Rattus argentiventer* and *R. losea*).

During an earlier ACIAR-supported project in Indonesia, Dr Grant Singleton from CSIRO Sustainable Ecosystems explained that breeding in ricefield rats appears to be triggered by the maturation of the rice plant itself, with females entering oestrous one to two weeks prior to maximum tillering. By the time the rice is ready for harvesting, a female may have had three litters and up to 40 offspring. This means it is crucial that females are removed from the population before or during the breeding season.

A TBS system uses an early-planted rice crop, established two to three weeks before the main crop, as a lure. These systems start catching rats while the surrounding (main) crop is at its milky (grain formation) stage, and if the system is working the number of captures drops away after this.

In Cambodia's Kampong Cham province where the system is being trialled, farmers are not only capturing a large number of rats, but are subsequently reporting yield increases of up to 70 percent in their main crops. The increased farm resources provided by such yield increases is also making farmers much more receptive to CARDI's efforts to encourage lowland farmers to intensify their production by double-cropping.

However, the drawback to the system is it needs a community-wide commitment. A 25 metre square trap will protect about 10 hectares. Because rats are mobile, travelling up to half a kilometre a night in search of food, there needs to be a network of appropriately spaced trap crops.

This means a whole community has to be committed to the concept, something which project leader (and deputy director) at CARDI, Ms Chan Phaloeun, says is the biggest challenge. "We've had lots of meetings to explain how the system works and why it needs everyone, but we find we are still learning how and why farmers think their way through these decisions. A farmer won't put in a trap if he thinks it will benefit a neighbour more than himself."

Because Cambodian farms are small this is inevitable. One trap for a 10 hectare area would mean one farmer providing the land and being responsible for the cost and maintenance, for the benefit of perhaps another five or six farms.

Phaloeun says the project has consequently become a challenging extension exercise. Whole communities have to be educated about rat biology and shown the extent and cost of rat damage. Once a community is clear about the issue, and can agree on the need to take action, then it becomes easier for a decision to share the costs of setting up and maintaining the trap units as a community exercise.

However, even that is only part of the answer. Besides trapping, the CSIRO rodent research team involved in the earlier work in Indonesia and Vietnam found the system's effectiveness was considerably improved by periodically collecting rats from their source habitats, by increasing general hygiene around villages and by synchronising cropping.

They found that if farmers planted their crops at different times, the rodent breeding cycle is effectively lengthened as the animals move from field to field and numbers can explode.

On the other hand, the benefits have been significant in districts where the TBS is well managed. Aside from increased crop yields, there have been ecological and health gains where control methods, such as poisons, have stopped being used.

PROJECT:

ASEM/2000/007 Farmer-based adaptive rodent management, extension and research system for Cambodia

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