Floating Rice in Vietnam, Cambodia and Myanmar

Nguyen & Pittock
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Front and back covers  Floating rice, Mekong Delta, Vietnam  
                      Kien van Nguyen, 2013

Inside front cover  High Yielding Variety Rice, Mekong Delta, Vietnam  
                    David Dumaresq, 2015

Page 3  Fishing in floating rice field, Mekong Delta, Vietnam  
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Floating Rice in Vietnam, Cambodia and Myanmar

Scoping floating rice-based agro-ecological farming systems for a healthy society and adaptation to climate change in the Lower Mekong Region and Myanmar

**Synthesis Report**
Based on Submitted Country Reports, Interviews and Field Observations

Prepared by Dr. Van Kien Nguyen, Luc Hoffmann Institute Fellow,
Fenner School of Environment and Society,
The Australian National University
& Director, Research Center for Rural Development,
An Giang University

**In consultation with**
Mr David Dumaresq,
Dumaresq Consulting Pty Ltd,
Canberra, Australia

**Key investigators**
Associate Professor Jamie Pittock,
Fenner School of Environment and Society,
The Australian National University

Dr. Van Kien Nguyen, Luc Hoffmann Institute Fellow,
Fenner School of Environment and Society,
The Australian National University
& Director, Research Center for Rural Development,
An Giang University

**Country Partners**
Vietnam - Research Center for Rural Development
An Giang University (AGU)

Cambodia - ECOLAND Research Center
Royal University of Agriculture (RUA)

Myanmar - Cooperative University, Thalyin, Myanmar
and Research Association for Development (ARD)
Abstract
The principle finding of this research project is that there is widespread and increasing recognition of the value and benefits of growing floating rice in the Lower Mekong Region for the countries of Vietnam, Cambodia and Myanmar. This is despite the widespread loss of traditional wet season rice cropping in the LMR, in particular floating rice, to modern high yielding rice varieties.

The project has identified the drivers for this loss of floating rice cultivation and the presence of continuing and future threats to its maintenance. Some potential avenues for mitigating these threats have been identified.

The value and benefits of floating rice to local farmers, rural communities and regional consumers have been provisionally identified. The difficulties of further extension for the use and marketing of floating rice in the region and beyond have been noted for further study.

The second major finding of this project is that there are available in each country (Vietnam, Cambodia, Myanmar) research sites, farmer organisations and research institutions and government agencies wishing to be partners in, and to provide support for, further research and extension of floating rice cropping systems; and for market development.
1. Introduction

The scope of this pilot study was to provide an appraisal of the traditional floating rice-based farming systems remaining in Cambodia, Myanmar and Vietnam. The study aimed to ascertain: a) the extent and location of remaining floating rice cultivation, b) the perceived benefits and costs of floating rice, c) any issues for maintaining and expanding floating rice systems, d) the commitment of government and other stakeholders to engage in a further floating rice research program, and e) priorities for such a research program.

The ultimate objective of this project was to assess the feasibility of a larger project in 2017-19 to promote the maintenance and extension of the traditional floating rice-based farming systems in Cambodia, Myanmar and Vietnam using the lessons learnt from the Vietnamese Mekong Delta for improving the profitability of traditional rice growing systems, maintaining and increasing the diversity of rice farming ecosystems, creating greater efficiency and reuse of natural resources, and improving the nutrition of poor communities.

The study was undertaken by staff from The Australian National University, Canberra, Australia; and staff from a partner research institution within each country studied. The investigation was done using a participatory action research design involving local and national government officials and other key stakeholders through a series of within country workshops and key person interviews conducted during 2016.

Key terms/glossary

<table>
<thead>
<tr>
<th>Key terms</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Yielding Variety (HYV) rice</td>
<td>Known as: ‘Short-term’ rice in Vietnam&lt;br&gt;Both wet and dry season rice in Cambodia&lt;br&gt;High Yielding rice in Myanmar&lt;br&gt;HYV rice has been bred to be photoperiod insensitive, with a reduced cropping time and to maximise rice yields through increased response to farm inputs. Up to 3 HYV rice crops per year per field are grown in some parts of the Mekong region</td>
</tr>
<tr>
<td>Floating rice (FR)</td>
<td>Known as: ‘Long-term’ rice or floating rice in Vietnam and Cambodia&lt;br&gt;‘Deep water’ rice in Myanmar&lt;br&gt;Floating rices are a range of traditional varieties adapted to large changes in flood water levels occurring during the growing season.</td>
</tr>
<tr>
<td>Paddies</td>
<td>Fields dedicated to rice growing</td>
</tr>
<tr>
<td>Paddy rice</td>
<td>Rice as harvested direct from the field – of variable moisture content</td>
</tr>
<tr>
<td>Dyke compartments</td>
<td>Enclosed compartments for agriculture created by building flood protection dykes</td>
</tr>
<tr>
<td>Water infrastructure</td>
<td>Sluice gates, pumping stations and other physical installations for controlling both flood and irrigation waters</td>
</tr>
<tr>
<td>Chemical free</td>
<td>Rice or other farm products perceived as free of agricultural chemicals and other pollutants but without certification or product testing to ratify actual contents</td>
</tr>
<tr>
<td>Lower Mekong region</td>
<td>Vietnam, Cambodia, Thailand, Lao, and Myanmar</td>
</tr>
</tbody>
</table>
2. Background to floating rice in Southeast Asia

As recently as the 1990s, cropping of floating rice (FR) was widespread globally. In the recent past it has provided a safe, nutritious and culturally significant staple food for millions of people. Some nine million hectares were cultivated in the lower river basins of the Ganges-Brahmaputra of India and Bangladesh (5.0 million ha), the Irrawaddy of Myanmar (1.28 million ha), the Mekong of Vietnam (0.57 million ha) and Cambodia (0.41 million ha), the Chao Phraya of Thailand (0.76 million ha), and across West Africa (0.16 million ha) (Catling 1992). At that time it was a key source of nutrition for more than 100 million people in Asia and West Africa (Kende, Knaap et al. 1998). FR has provided a long-term staple food source for those peoples living in flood prone river basins and deltas through its unique crop adaptation process. As the floodwater rises the stem can elongate at rates of 20 to 25 centimetres a day enabling the head of the plant to remain safely floating on the surface, hence its name: ‘floating rice’ (Kende, Knaap et al. 1998). FR thus provides a biological solution to the agro-ecological problem of variable flood depths facing rice farmers during the rainy season. Despite its relatively low yield compared to modern high yielding varieties (HYV), FR has been seen to have a range of other advantages. As a traditional rice variety, FR has been largely grown without the addition of agricultural chemicals (Nguyen and Huynh 2015, Nguyen, Vo et al. 2015) and as such is seen as been safe and nutritious. FR fields have abundant biodiversity compared with other paddies and contain substantial fish and other aquatic animals (OAA) which can be harvested as valuable food protein sources for riverine peoples (Nguyen and Huynh 2015). A case study example of a traditional FR cropping system from the Mekong Delta is given in Box 1.

Box 1: Floating rice in the Mekong Delta

Starting in the April dry season farmers prepare their paddies for the next wet season rice crop by burning any remaining rice straw and then ploughing usually using two water buffaloes. When the first rains fall in April, they cultivate again by harrowing and then sow floating rice by broadcasting at a rate of 100 kg rice seeds/ha. The farmers then harrow again to cover the seed to prevent bird, and mice damage, and maintain good soil moisture for germination. During the flood season from August to October, the rice plants elongate their stems keeping the developing flowering heads above the water. Farmers report that FR can grow up to 10 centimetres a day during rapidly rising flood times. When the flood water recedes in November, the rice plant falls flat on the ground and then flowers. The rice was harvested by sickle between December and January. In this traditional cropping system water buffaloes or other cattle play an important role as draught animals providing the motive power for ploughing, harrowing, transporting the harvest to higher ground and for threshing the rice. Post harvest some farmers may use the remaining soil moisture and silt deposit from the flood to cultivate dry season crops (eg, sesame, water melon, mung bean), to be harvested before the next flood event.
3. The distribution of floating rice in Vietnam, Cambodia and Myanmar and its recent changes

3.1 Vietnam

Floating rice was once widely distributed in both shallow and deep flooded areas across the Mekong River Delta (MRD) in Vietnam, particularly the Long Xuyen Quadrangle and the Plain of Reeds (Vo 1975, Nguyen Huu Chiem 1994). Two species of FR are typical of the MRD, Oryza sativa L and Oryza prosative (Vo and Matsui 1998). FR used to be a main source of high quality food and has significant cultural, ecological, environmental and historic values for the peoples of the MRD region (Nguyen and Huynh 2015). Before 1975, the total area of FR was estimated at over 500,000 hectares, of which 50% (250,000 ha) was distributed in the province of An Giang alone (Nguyen Huu Chiem 1994, Vo and Matsui 1998, Biggs, Miller et al. 2009). By 2015, the cultivated areas of floating rice were less than 200 ha.

Despite this almost complete disappearance of FR from the MRD in Vietnam it is important to note that since 2012 the area of FR has been steadily growing as its benefits become more widely recognised.

The decline and almost total disappearance of FR from the Vietnamese MRD by 2012 is due to two main factors; agricultural policy reform and the construction of dike compartments. In the last three decades, Vietnam adopted rice intensification policies to maximize the area devoted to rice cropping and to increase the production per unit area through promoting high yielding varieties and increased chemical inputs. The MRD is a typical example where the paddy production (HYV) has increased from 7 million tons in 1986 to 25 million tons in 2013 (GSO 2014).

Much of the area in the MRD given over to HYV rice has also been converted to dike compartments. The dyke compartments are created by the construction of high dykes encircling a rice growing area completely excluding floods. While these compartments are protected from external flood waters they also require the construction of sluices and pumping stations to both control and remove internal flooding and to pump in irrigation water during dry season cropping (Nguyen, Vo et al. 2015). Where farmers previously grew one FR crop per year during the wet season flood, now, they can grow two or three crops of HYV rice protected from floods and watered through controlled irrigation systems.

3.2 Cambodia

In Cambodia, in the recent past, floating rice was distributed in most provinces around Tonle Sap and in the Cambodian Mekong Delta. In 2010, the country had 95,858 ha of FR which had reduced to 46,759 ha by 2015. Although floating rice remains in 9 out of 26 provinces, primarily cultivation is limited to six provinces near Tonle Sap, being Siem Reap, Kampong Thom, Kampong Chhnang, Pursat, and Banteay Meanchey. In 2015, Kampong Thom had the largest area at 12,165 ha (26% of Cambodia’s FR crop).

This rapid reduction in FR areas can be seen to be due to the Cambodian Government’s promotion of short-term high yield rice cultivation aimed at producing a domestic rice surplus enabling rice exports to develop. The government plans to expand infrastructure-based irrigated agriculture to enable at least two or three rice crops per year in many areas. In
2010, there were 773,188 hectares under crop reported for the wet season and a further 347,048 hectares of irrigated crop in the dry season (De Silva, Johnston et al. 2014).

The National Strategic Development Plan proposes expanding the irrigated rice area to 867,000 ha and increasing yields to 3.25 t/ha for production of 10.85 Mt/yr and the rice surplus of 6 Mt/year (Royal Government of Cambodia).

3.3 Myanmar
Myanmar has the largest cultivated areas of floating rice [know as ‘deep water’ rice in Myanmar] in South East Asia. In 2010 the total areas of FR were 850,257 ha. By 2015, this had been reduced to 745,037 ha distributed across six regions (1) Kayin (36,566 ha), (2) Mon (42,048 ha), (3) Tanintharyi (20,249 ha), (4) Bago (217,379 ha), (5) Yangon (98,811 ha), and (6) Ayeyarwady (329,982 ha) (Tun 2016).

Ayeyarwady delta region has the greatest area at 329,983, accounting for 44.3% of the country’s total. Again it is important to note that while the areas of FR were decreasing in some regions, in Ayeyarwady, Bago and Yangon they are increasing.

According to the World Bank (2014) the Myanmar Government plans to export 4 million tons of rice in 2020, up from 1.3 million tons in 2014. As the average rice yield is low in Myanmar compared to other Mekong countries, the government plans to invest in both yield improvement strategies and increased land and water resources allocated to rice production through the establishment of small scale irrigation schemes.

However, in Myanmar (and to a degree other LMB countries) FR is at risk to HYV rice due to a range of impacts other than just government agricultural policies. These include (1) impacts of climate change (abnormal floods and droughts), (2) lack of market for FR as human food (FR is primarily used as feed for livestock) (3) lack of farmer knowledge about integrated FR-based farming systems that include other profitable dryland vegetable crops, and (4) lack of suitable genetic material among traditional floating rice varieties in Myanmar that prevents crop adaptation to mitigate risks from changing flood regimes.
4. Drivers for the loss of floating rice areas

Key drivers for the significant loss of the areas of floating rice in all three countries include (1) changes in agricultural policies to promote the production of domestic rice surpluses and to develop rice exports, (2) concomitant development of water infrastructure for flood control and dry season irrigation that enhances development of HYV rice, (3) development of extensive hydropower dams for energy generation and other major non-agricultural water uses, (4) developed international markets for HYV rice, and a corresponding lack of international and domestic markets for FR, (5) lack of research and development for FR, and (6) climate change (abnormal floods and droughts).

4.1 Agricultural policy

Vietnam as the country to first (mid 1980s) introduce major agricultural reforms to increase overall rice production including production for export has suffered the most loss of its FR areas with 0.1% remaining. Cambodia introducing similar policies in the 1990s has some 11% remaining. This trend is accelerating with more than half of the 2010 areas lost in the last 5 years. Myanmar has just introduced such policies and as yet retains nearly 60% of its FR areas. While government agricultural policies directed towards increasing national rice output are not the only cause for the loss of FR areas in the Mekong region, it is clear that they are a major trigger for a rapid decline in traditional rice cropping systems including floating rice.

As Section 1 demonstrates there has been a major loss of rice growing areas devoted to FR across Vietnam, Cambodia and Myanmar in the 40 years since 1975. Table 1 sets out the range and trends of these losses.

Table 1: Loss of Floating Rice Areas c.1990-2015

<table>
<thead>
<tr>
<th></th>
<th>c.1990</th>
<th>2010</th>
<th>2015</th>
<th>% Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vietnam MRD</td>
<td>570,000</td>
<td>na</td>
<td>200</td>
<td>99.9</td>
</tr>
<tr>
<td>Cambodia</td>
<td>410,000</td>
<td>95,858</td>
<td>46,759</td>
<td>88.6</td>
</tr>
<tr>
<td>Myanmar</td>
<td>1,280,000</td>
<td>850,257</td>
<td>745,037</td>
<td>41.8</td>
</tr>
<tr>
<td>Total</td>
<td>2,260,000</td>
<td>791,996</td>
<td></td>
<td>65.0</td>
</tr>
</tbody>
</table>

4.2 Development of water infrastructure

Governments across the Mekong region plan to expand irrigation infrastructure for intensification of rice production following the direction taken in the Vietnam MRD. There the expansion of water management systems has led to the almost total exclusion of FR. Such water management development, in Cambodia and Myanmar are likely to lead to similar conversion of the current FR areas to HYV rice production.

In Vietnam’s MRD provincial governments have invested in a massive network of dikes and irrigation systems in the last two decades to promote rice production for export (Thủ tướng Chính phủ [Prime Minister] 1996). Paddy production in the Mekong Delta increased from 7 Mt in 1986 to 25 Mt in 2013 due to increase in rice yields and the number of rice crops a year (Box 2).
Box 2: Rice intensification and high dikes in the Mekong Delta – the Vietnam Experience

The Mekong Delta as a large flat alluvial plain is uniquely suitable for rice cultivation. The delta is flooded each year from July to November by flow from the Mekong river system. The Mekong rises in the Tibetan Plateau flows through southern China, Laos, and Myanmar, Thailand, Cambodia, and exits to the sea through the MRD. Prior to the 1980s, the majority of the delta was farmed for one crop of long-term [floating] rice a year grown over the wet season from April to December (see Box 1). Since the introduction of HYV rice some sections of the Vietnamese MRD have been modified to provide year-round flood protection by the construction of high dikes exceeding known peak flood levels. These dikes are then joined to form compartments with sluice gates installed to exclude floodwater but allow water in and out of the compartment as required.

Once the dike compartments are constructed, water management inside the compartment becomes part of overall farming management rather than part of the natural flood cycle driven by seasonal river levels. Large scale pumping equipment (often electrically powered) has to be installed to control water levels inside the compartment. Pumping is required both for dry season irrigation and for the removal of internal compartment floodwater especially during the rainy season. Both the timing and level of water within a compartment becomes a matter of collective agreement for all farmers within that compartment as all will receive the same level and timing of water. As farm size tends be less than 5ha, the agreement of many farmers (>50 on average) is needed for any particular water regime to be instituted in a compartment. Individual farmers within a compartment cannot choose to grow FR while others grow HYV rice requiring different levels and timings of water.

For example, An Giang province had 629 dike compartments which range in area from 12 to 3,486 ha of agricultural land, averaging 384 ha, with a median value of 250 ha per compartment. Three crops of HYV rice are usually cultivated annually inside a compartment. Each crop lasts from 100 to 110 days. The average yield is 6-7 tons/ha.

Source: Nguyen Van Kien et al. (In press)

As the Vietnamese MRD example illustrates, the ability for any individual farmer to grow FR within managed water infrastructure developments such as high dike compartments is severely limited if not impossible. As more and more water infrastructure developments proceed across the Mekong region, FR growing will become increasingly restricted to those rice growing areas outside such developments.

The Cambodian Government plans to expand infrastructure-based irrigated agriculture to increase rice cropping from one to two or three crops per year, increasingly to supply export markets. By 2010, there were 773,188 hectares under crop reported for the wet season and a further 347,048 hectares of irrigated crop in the dry season. The National Strategic Development Plan proposes expanding the irrigated rice area to 867,000 ha and increasing yields from to 2.5 t/ha in 2007 to 3.0 t/ha in 2020 for production of 7.5 Mt/yr by 2020 (Yu and Diao 2011). The proportion of irrigated land is projected to increase 20% by 2020 (Yu and Diao 2011).
This project’s findings indicate that there remains some 46,759 hectares of FR areas in Cambodia under potential threat for replacement by HYV rice (ECOLAND Research Center 2016).

In Myanmar, the process of increasing rice intensification through moving to HYV crops and developing large scale water infrastructure to allow year round cropping is still in its early stages. However, the threat to FR from these policy decisions already undertaken remains very real if Myanmar’s process of rice intensification follows that of Vietnam and Cambodia.

4.3 Developed markets for HYV rice and a lack of domestic and international markets for FR

Vietnam, Cambodia and Myanmar reported that while HYV rice has a clear domestic and international market acceptability, the same cannot be said for FR.

In Vietnam the difficulties with marketing floating rice included:

i) Unreliable supply due to the very small quantities available,

ii) Poor prices available to farmers,

iii) Much FR is consumed by farmers themselves as they prefer FR to HYV rice for home consumption,

iv) FR is unfamiliar to many, especially younger, consumers. Many find it is ‘hard’ to eat and has an unfamiliar taste,

v) FR is difficult to mill and tends to shatter during processing,

vi) There is a lack of standardisation of quality in FR both as seed stock and as a consumer commodity.

Besides the Vietnamese problem of the lack of availability of FR, both Cambodia and Myanmar report similar sets of issues for marketing floating rice. In addition Cambodian farmers reported a preference for eating FR at home as they believe it to be both safe and more nutritious than the HYV rice available in markets (such as the IRR504, variety, imported from Vietnam). While Cambodian farmers consume it at home, it remains unpopular in urban markets. Local governments in Kampong Thom province perceive that floating rice is ‘hard’ and not suitable for sale as food, so they have encouraged farmers to use FR to make rice wine as a local ‘value adding’ process to enable FR to be marketed.

In Myanmar, while the native floating rice is also perceived as hard to eat, the marketing response is very different. FR is grown as animal feed. It was reported to this project that no floating rice is sold in supermarkets and local shops as human food. FR is sold as paddy into local markets for either direct use as animal feed or as an input for making stock feeds.
4.4 Research and development support for floating rice

Prior to the 1980s, the International Rice Research Institute (IRRI) and rice researchers in Southeast Asia conducted research on FR and other traditional rices as well as HYV. HYV rice with high yields, short growing times and the possibility of 2 or 3 crops per paddy per year revolutionised rice farming through the region. Subsequently, from the mid 1980s on, the research and development focus shifted entirely to HYV and research on floating rice with its low yields and long duration cropping cycle stopped. Knowledge about the farming of FR in the Mekong region has subsequently relied on long-standing farmer experience and traditional practices until recent developments in Vietnam.

There are several consequences of this lack of R & D on FR in Cambodia and Myanmar. Firstly, farmers may not have the skills and knowledge for successful implementation of integrated FR cropping systems that include the use of dry season vegetables crops after the harvesting of floating rice. FR farmers usually leave rice fields fallow after harvests although across Cambodia these dry paddies are used for water buffalo and cattle grazing. Knowledge of cropping systems is held by individual farmers at the local level with little or no coordination for extension, training or farm systems development. Secondly, there has been little or no development of FR seed quality and genetic improvement across the two countries. In Cambodia farmers retain their own seed for the next planting with little purification or selection for improvement being undertaken. In Myanmar, the government seed bank collects and maintains FR seed sources but does not undertake FR seed purification, breeding, improvement or extension.

Having seen the almost complete elimination of FR from the MRD, the R&D situation in Vietnam is now radically different. Since early 2013, the Research centre for Rural development (RCRD) at An Giang University has been pioneering research and development activities aiming at recovering the remaining floating rice in the Mekong Delta and extending its adoption. The project’s success is demonstrated by the increases in both FR areas sown every year since 2013 and the number of farmers returning to cultivate floating rice. Consequently a growing number of Vietnamese farmers are advanced in floating rice-based farming systems practice. Farmers have successfully rotated several profitable dry season crops such as chili, baby corn, pumpkin, cassava, leeks, taro, and cucumbers. A further indication of the success of this R&D initiative is that several local governments from other flood prone provinces of the Mekong Delta have requested technical support from RCRD to recover the floating rice-based farming system for diversifying farming livelihoods in the region.

A further outcome of the RCDC floating rice initiative is the identification of several key issues for promoting commercial floating rice farming systems and for marketing FR in wider, including global, markets. RCRD has identified seed selection and purification as key for the development of the FR industry and has initiated a community-based seed purification program over the last three years. RCRD has collected 187 flower phonotypes and over 800 promising pure varieties of floating rice. Of which over 100 pure collected varieties and 26 populations were assessed from the 2015 to 2016 crop. RCRD has identified some potential rice varieties for continuing selection process.

The RCDC R&D initiative in the MRD demonstrates how vital a focussed research and development program is for the floating rice industry across the Mekong region.
5. Value and Benefits of Floating Rice

5.1 Agronomic benefits

In detailed Vietnamese research into the agronomic costs and benefits of FR versus HYV rice in the MRD shows that the economic benefits of integrated floating rice based systems can be higher than the mono, double or triple cropped HYV rice systems. The mono crop, intensive short—term HYV system requires high pesticide, fertilizer, labour and water inputs that produce greater yields of rice, but creates less net economic return compared to an integrated floating rice system (Nguyen, Vo et al. 2015). Farmers can rotate several dry season crops after harvesting floating rice. Depending on the location, these are likely to be cassava, leeks, taro in strong acid soils areas, and baby corn and chilli in more fertile alluvium soils. All can integrate cattle into their cropping systems.

HYV rice yields in the MRD are about 5.9t/ha per crop. The paddy price taken in this analysis is USD$530/t. The net economic return for double and triple rice crops is USD $1,110 and USD$2,150 per hectare respectively. For FR alone, the net return is only USD$500/ha, with yields in the range 1.5-2.0t/ha per crop. However, for those farmers combining FR and cassava, the net return is USD$1,970/ha, higher than double cropped HYV rice alone but lower than triple crossed HYV. For those FR farmers combining floating rice and leeks or chilli, the net return is USD$11,130 or $7,930 per hectare respectively. Those combining floating rice plus baby corn with cattle, the return is USD$8,300/ha. It should be noted that while the floating rice crop is usually free of chemical use in Vietnam, these farmers still apply fertilizers, pesticides, and irrigation water inputs for the dry season vegetables crops.

In Cambodia, the net return of floating rice is much lower than in Vietnam. While average yields of floating rice and HYV rice are similar to those in Vietnam (1.5 to 2.0 t/ha and 4.5-6t/ha respectively), the market prices of both FR and HYV rice are lower. FR price is 700 riel/kg (USD$190/t) while it is 800 riel/kg (USD$ 200/t) for HYV rice. But it is the cropping systems that make the difference. Table 2 sets out the yields, prices, income, costs and net returns for HYV and FR in Cambodia.

Table 2: Comparison of Cambodian HYV and Floating Rice Returns

<table>
<thead>
<tr>
<th></th>
<th>Yield</th>
<th>Price</th>
<th>Income</th>
<th>Chemical Costs</th>
<th>Other Costs</th>
<th>Return 1</th>
<th>Water &amp; Rent Cost</th>
<th>Return 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>HYV</td>
<td>4.65</td>
<td>200</td>
<td>930</td>
<td>220</td>
<td>344</td>
<td>366</td>
<td>236</td>
<td>130</td>
</tr>
<tr>
<td>FR</td>
<td>1.6</td>
<td>190</td>
<td>304</td>
<td>47</td>
<td>140</td>
<td>117</td>
<td>$/ha</td>
<td>$/ha</td>
</tr>
</tbody>
</table>

In terms of costs, HYV farmers in Cambodia spend almost 5 times more ($220/ha) on chemical inputs than FR farmers ($47/ha). Herbicides are the main chemicals inputs for floating rice. FR crops cost 4 times less than HYV crops because low labour, seed, and water or rent costs. Where HYV rice farmers have to buy water as well as rent land, the returns per hectare start to approach those of FR farmers. However, FR returns are overall lower than HYV cropping without integrated dry season cropping systems. Note that the returns from dry season cattle grazing on dry paddies are not included in the analysis in Table 2.
In Myanmar, like Cambodia, many farmers grow FR as a single wet season crop followed by a fallow period without the integration of dry season crops. However, in some provinces existing multiple cropping systems were reported. These included cropping patterns of: rice-pulses (34% of Ayeyarwady Region crops in 2003-4), rice-oilseed (9%), and rice-vegetables (7%). The existence of local multiple cropping systems across both wet and dry seasons in some Myanmar regions indicates that there exists considerable scope for increasing farmer returns for such systems incorporating FR.

Table 3 sets out the indicative returns for a single wet season Myanmar FR crop.

<table>
<thead>
<tr>
<th></th>
<th>Yield</th>
<th>Price</th>
<th>Total</th>
<th>Seed</th>
<th>Tillage</th>
<th>Labour</th>
<th>Weeding</th>
<th>Harvest</th>
<th>Total</th>
<th>Net Return</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>t/ha</td>
<td>USD$</td>
<td>USD$</td>
<td>$/ha</td>
<td>$/ha</td>
<td>$/ha</td>
<td>$/ha</td>
<td>$/ha</td>
<td>$/ha</td>
<td>$/ha</td>
</tr>
<tr>
<td>FR</td>
<td>1.75</td>
<td>210</td>
<td>368</td>
<td>31.5</td>
<td>63</td>
<td>3.25</td>
<td>31.5</td>
<td>94.5</td>
<td>224</td>
<td>144</td>
</tr>
</tbody>
</table>

With yields of 1.75 tons/ha and a price of USD$210/t, the total return is USD$368/ha. The total costs per crop are USD$224. These costs include seed (USD$ 31.5/ha), tillage (USD$63/ha), labour (USD$3.25/ha), weeding (USD$ 31.5/ha), and harvesting (USD$94.5/ha). This gives a net return of USD$144/ha which is substantially higher (23%) than that for FR cropping in Cambodia. However, floating rice net returns per ha in both Cambodia and Myanmar without the integration of dry season cropping systems is much lower than in Vietnam. It should be noted that in Myanmar FR yields ranging from 1.6 to 3.75 t/ha were reported, indicating that substantial overall yield improvement is possible. As was noted at the Myanmar workshop, fertiliser use for rice growing has been falling across the whole country in all rice areas and types, so an increase in appropriate fertiliser use would likely see immediate yield increases for all rice crops, including FR. The cost/benefit outcome of such fertiliser applications would be the subject of future research; as would reasons for falling fertiliser use and barriers to its reintroduction.

5.2 Fisheries and food security
Research in Vietnam has shown a very significant link between the development of multiple crop HYV rice system, the decline in FR farming and the loss of wild fish catch. Fish populations are rich in the floating rice fields of Vinh Phuoc commune with 20 species of freshwater fish (across 8 families) while there were only 5 species (across 4 families) in the triple cropped rice fields nearby (Nguyen and Huynh 2015). Prior to rice intensification in the 1980s, the MRD produced 80-90% of total freshwater fish catch in the south of Vietnam with much of this coming from the flooded rice fields during the wet season (Taki 1975). In such a traditional integrated farming and fishing system, rural households collected inland fish for daily meals and cultivated one floating rice crop per year. These food sources provided the calorie and protein staples for a secure, nutritious diet for millions of people (Vo 1975). More recent Vietnamese research has established that the loss of tradition rice growing systems across the MRD with its concomitant loss of wild fish does result in a major loss of fish from the MRD diet and a potential loss of a major protein source for the regional diet.

In Cambodia, inland fisheries contributed 65 to 75% of animal protein for rural households in rice farming areas of Svay Rieng (Guttman 1999). It was estimated that a hectare of rice fields
can provide 80 kg/year of edible fish (catch range of 30 to 86 kg of fish/year/household) (Guttman 1999). It is further estimated that 70% of the Cambodian population depends directly for food or livelihoods on the wild fish catch from the Mekong River and the annual flooded rice fields (ICEM, 2010).

In Myanmar the importance of fisheries combined with wet season rice growing was noted but no data was forthcoming for this project.

In summary, the wild fish catch from FR systems in the MRB is a major component of the regional food supply. The loss of FR farming systems in the LMB poses a major threat to regional food security.

5.3 Development of aquaculture in the floating rice fields

Recognizing the importance of fisheries as part of the traditional integrated floating rice farming system, farmers in Dong Thap province in Vietnam are developing aquaculture as a means of integrating fresh water fish into the redeveloped floating rice fields to improve income for farmers. Trials integrating floating rice with aquaculture and having a dry season upland crop found substantially increased economic returns compared to that of a two HYV rice crop [USD$ 3,866/ha in comparison with USD$901/ha] (Research Centre for Rural Development 2016). However, despite the success of these trials, convincing farmers to adopt such an integrated aquaculture and multiple crop system has proved difficult in the last two years.

The development of aquaculture integrated into wet season rice cropping systems is recognised in Cambodia but has yet to be implemented at any scale to replace the loss of wild fish catch. In Myanmar, a long tradition of keeping fish ponds in the deep water rice areas was reported. However, the further development of both extended cropping seasons and aquaculture in some areas is limited due to already strong competition for available water between agriculture and aquaculture.

5.4 Environmental benefits

5.4.1 Ecosystem services for agriculture

While intensification with HYV rice has produced very large increases in the total volume of rice available annually across the LMB, it has also brought major costs that have not been recognised until very recently. Researchers from the RCRD have found that intensification has the following costs (1) inland fishery losses due to water pollution and reduction in fish habitats due to the construction of dikes, compartments and other irrigation infrastructure, (2) soil and water quality degradation (Research Centre for Rural Development 2016). This degradation is partly due to the loss of annual flooding that both brought silt that enriched soils and flushed away accumulated waste. It is also a consequence of the intensive use of agri-chemicals, (3) loss of common pool nutritional resources for households (fish and other wild foodstuffs), and (4) increasing water and electricity use for irrigation and drainage (Research Centre for Rural Development 2016). Overall the introduction of HYV rice systems has seen the replacement of the naturally occurring ecosystem services by large scale inputs from industrial agriculture.

The preservation and redevelopment of floating rice based farming systems can maintain these ecosystem services.

In Cambodia, rice fields are seen as providing a range of ecosystems services and considerable work has been done in detailing these services and their accompanying dis-services for the
three different rice growing systems. These are the 1 to 3 crops of short duration HYV rice per year; secondly, comes the medium to long duration rainy season rice (non-FR); and thirdly, FR systems. All three systems provide a range of services set out in Table 4 (Neang, Meral et al. In Review).

Table 4. Ecosystem Effects in Cambodian Rice Cropping Systems

<table>
<thead>
<tr>
<th>Cropping System</th>
<th>Ecosystem Services</th>
<th>Ecosystem Dis-services</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short Duration HYV rice</td>
<td>Provisioning Services</td>
<td>Disturbed water regime &amp; silt deposition, altered flood regulation of Tonle Sap ecosystem. Degraded habitat, biodiversity and natural flood regime. Degraded soil and agro-biodiversity and polluted water. Reduced wild &amp; cultivated genetic resources for daily food consumption</td>
</tr>
<tr>
<td>1 or 2 crops per year</td>
<td>Flood regulation</td>
<td></td>
</tr>
<tr>
<td>1 crop early rainy season or</td>
<td>Palm leaves, wood, fruit and seeds for farmer’s own needs</td>
<td></td>
</tr>
<tr>
<td>1 crop flood recession season</td>
<td>Can preserve spiritual practices and value of agricultural landscape, eg paddies with palm trees</td>
<td></td>
</tr>
<tr>
<td>or Double crop</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medium to Long Duration Rainy Season Rice</td>
<td>Supporting Services</td>
<td>Some degradation of wild and cultivated genetic resources Some loss of rice genetic material from gene bank</td>
</tr>
<tr>
<td>Maintenance of water regime and silt deposition</td>
<td>Provisioning Services</td>
<td></td>
</tr>
<tr>
<td>Palm leaves, wood, fruit and seeds for farmer’s own needs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preservation of natural varieties of plants &amp; animals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preservation of indirectly flooded ‘clear’ forest for habitat and biodiversity maintenance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preservation of agro-biodiversity of fauna and flora in paddies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance of water quality through low/no chemical use</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cultural Services</td>
<td>Preservation of spiritual practices and value of agricultural landscape, eg paddies with palm trees</td>
<td></td>
</tr>
<tr>
<td>Floating Rice</td>
<td>Supporting Services</td>
<td></td>
</tr>
<tr>
<td>Maintenance of water regime and silt deposition for soil formation</td>
<td>Provisioning Services</td>
<td></td>
</tr>
<tr>
<td>NTFPs, firewood, inland fish.</td>
<td>Preservation of natural rice genetic material, &amp; other plants &amp; animals</td>
<td></td>
</tr>
<tr>
<td>Preservation of water quality through no chemical residues</td>
<td>Regulating Services</td>
<td></td>
</tr>
<tr>
<td>Preservation of directly flooded ‘clear’ forest for flood regulation, habitat and biodiversity, soil and water quality maintenance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preservation of agro-biodiversity of fauna and flora in paddies</td>
<td></td>
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</tr>
<tr>
<td>Maintenance of water quality through no chemical residues</td>
<td>Cultural Services</td>
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<tr>
<td>Preservation of spiritual practices and value of agricultural landscape, eg paddies with palm trees</td>
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</tbody>
</table>
In particular, the Provisioning Services include not only rice but fish, other aquatic animals (OAAs) and medicinal materials for local people (Halwart 2006, Halwart 2008). The Mekong flood plain provides the principle fishing and OAA hunting grounds for the local people. These combine to provide the principle protein sources for local people who have limited access to market food because of the distance to market and/or are too poor to buy food. Rice field agroecosystem is also source of green manure as well as compost composition for organic and other traditional rain fed seasonal rice cropping system. Cambodia rice fields also provide a commercial supply of OAA such as frog, snake, eels, rats/mice and insects to neighbouring counties such Thailand and Vietnam. Consumers outside Cambodia strongly believe that Cambodian farmers use less chemical inputs than their own farmers and thus Cambodian wild products are free from contamination. In Cambodia it is well recognised that if floating rice farmers continue to produce on existing rice fields and keep traditional vegetation such as Roneam trees (clear flooded forest) in their rice fields, floating rice systems can contribute to fishery natural resources management, i.e. that these management systems are mutually supporting.

In Myanmar, it is well recognized that the floating rice system also provides fish and other aquatic resources. It was also reported that the loss of these benefits comes with the conversion to irrigated HYV rice. However, little information is available for documenting these benefits or their loss. Further research is needed.

In summary, the wild fish catch from FR systems in the MRB is a major component of the regional food supply (Hortle 2007, Hortle, R et al. 2008, Nurhasan, Machre et al. 2010, Hortle, Addison et al. 2013, Youn, Taylor et al. 2014). The loss of FR farming systems in the LMB poses a major threat to regional food security.

5.4.2. Biodiversity protection in the floating rice fields
Rice field based research has shown that there are more flora and fauna species in the FR fields in comparison with the HYV rice fields. The RCRD found that there were 68 species of flora (37 families) in the FR fields in Vinh Phuoc commune and 56 species of flora (25 families) in FR fields in My An commune. In contrast, 30 species (20 families) found in HYV fields (three crops a year) in My An commune. Furthermore, there were 34 species of birds found in the FR fields in Vinh Phuoc commune, however, only 12 species of birds found in the HYV fields in My An commune. Results also showed that there were 13 species of reptiles in FR fields in Vinh Phuoc commune and 12 species of reptiles in the FR fields of My An commune again indicating that the increased biodiversity was a FR effect rather than a regional location effect. The researchers concluded that the floating rice fields attracted more freshwater fish, flora and fauna species than the areas where triple crops of rice were cultivated for several years across several different communes.

In Cambodia, the agroecosystems around Tonle Sap are divided into 3 zones, each providing its own particular combination of ecosystem services and assemblages of fauna and flora. Biodiversity conservation and protection is strongly allied to this zoning system and its impact on agricultural activity. Zone 3, at the lower levels, is flooded early in the rainy season and remains flooded from July to November. This is the Zone most associated with the growing of
receding and floating rice. It is also the wildest zone and is characterised by the presence of Roneam and a combination of flooded shrub lands, grassland and paddy fields. FR is often planted under the Roneam - the flooded forest. Such rice cropping precludes the use of machinery and limits the use of inputs such as fertilisers and other agri-chemicals. This zone is seen as having the highest biodiversity value.

In Myanmar, the loss of both faunal and floral biodiversity is widely recognised with the continual clearing of mangroves and other forested land for rice growing. However, little data seems available on this loss across differing rice systems.

5.4.3 Health impacts

Across the LMB there is a widespread view, especially among farmers and older people, that eating FR is much healthier than eating modern HYV rice. In part this view is based in the belief that as little or no agri-chemicals are used in the growing of FR, then it is free of chemical pollution and much safer to eat. This is despite there being no formal testing or certification of FR as being chemical free or Certified Organic.

In Vietnam, people were used to consuming floating rice before the introduction of HYV rice. Floating rice is perceived as safe, chemical free and nutritious (Box 3). Monks and rich or older people in Ho Chi Minh City or in the Mekong Delta are its main consumers. It is thought that floating rice can cue chronic ills.

Similarly in Cambodia, farmers believe that eating floating rice is a healthy choice because it stimulates blood circulation, release joint pains. It is even thought suitable for diabetics. Farmers affirm that when eating floating rice; they feel full of energy to work long hours. Also they view FR as safer as they do not apply chemical fertilizers and pesticides to floating rice as they do for HYV rice such as IR50404.

The situation in Myanmar is very different - FR is used as stock feed despite some older people acknowledging that it was eaten and enjoyed in the past. There is some recognition of the possibility of marketing FR as human food through gaining Organic Certification.

**Box 3: Nutritional value of floating rice in the Mekong Delta, Vietnam**

- Floating rice has high protein: 11.3-11.5%, higher than HYV white rice
- Vitamin E: 56.5-69.9 mg/kg, five times higher than HYV white rice.
- Anthocyanin is high (0.35-43.6mg/kg) compared to none in milled HYV rice.
- Vitamin E content is also high (56.5-68.90mg/kg) as compared with HYV white rice (12mg/kg).
- Amylose content ranges from 18.83±0.61% (0% milled FR) to 27.96±0.61% (16% milled FR)

**Source:** Ho and Tran (2015).
Recent research done in Laos indicates that Laotians consumed more than 200 aquatic species found in the rice farming areas which contained a high level of essential nutrients for the local diet. In particular, these non-rice species used as food are a major source of protein for the farming communities. (Nurhasan, Maehre et al. 2010). Similar effects can be expected in traditional wet season rice growing areas across the other LMB countries.

These freshwater food resources are very rich in protein and micro nutrient, but their values are often neglected by decision makers in making choices about using water resources (Youn, Taylor et al. 2014).

5.4.4 Cultural values
As can be seen from Table.4 detailing the ecosystem services delivered by rice farming systems, cultural values form an important part of the rainy season and FR systems. Similar reports come from Vietnam and Myanmar. The cultural values of the traditional rice growing systems that are retained under floating rice systems include:

1. Spiritual values
2. Traditional rice growing landscapes that are both aesthetically pleasing and productive
3. Traditional or just habitual use of many wild resources that are enabled by such farming systems including, drinking water directly from the fields without fear of poisoning, firewood collection, hunting and fishing
4. Traditional foods and their tastes including the particular taste of floating rice much favoured by older people.
5. The harmonious combination of rice growing with other useful activities. In particular FR is seen as harmonious with the traditional use of the paddy fields as a grazing common in the dry season and as a fishing commons in the wet season. The rise of irrigated rice cropping systems in both the wet and dry seasons sees the loss of the paddy fields as a fishing or grazing commons for the local community.
6. Current threats and Barriers to Change

Floating rice farming systems in the Mekong region and Myanmar are facing a range of physical, biological and social threats. These include climate change, hydropower dam development, flood levee and dike compartment construction, the continuing rapid expansion of HYV rice and associated irrigation systems, emergence of new pests and diseases, low yields and the declining quality of floating rice varieties. The capacity of regional farming systems to cope with these threats is hampered by several barriers to change in farmer, consumer and market perceptions of floating rice.

6.1 Hydraulic changes

Changes in the timing, duration and levels of water depths are being noted throughout the LMB. These changes are all likely to increase in the immediate future. Climate change is likely to result in what traditionally would have been seen as abnormal floods and droughts making successful crops of floating rice difficult to achieve. Reports from Vietnam already indicate that the recent low level of wet season flood water has had a major adverse impact on floating rice farming in the Mekong Delta. In Myanmar floods are recently reported to be more extreme with water levels too high for floating rice to adapt; and with widespread gravel and rock debris being transported across paddies. While in Cambodia variable flood peaks during the growing season are damaging floating rice crops.

Large scale water management infrastructure is rapidly being built across the LMB. The planned construction of 77 tributary and 11 main stem dams on the Mekong River for hydropower generation will radically alter seasonal water flows. The average height of the planned dams is 50m indicating that large scale impoundment will take place and that water release will be done to suit electric power generation needs not rice growing (Orr et al, 2012). Such major changes to river flows may make growing FR impossible in some traditional farming areas. In lower areas, especially in the MRD, flood levees and dike compartment construction is excluding natural flood regimes entirely from many paddy areas. These changes not only encourage conversion to HYV irrigated rice, but also exclude the growing of FR.

6.2 Pests and diseases

Pests and disease infestations in rice crops are changing rapidly in many LMB areas. The absence of traditional long dry season fallows between rainy season rice crops have allowed a range of pest and diseases to build up and remain in the paddies year round. The presence of HYV rice year round, and in various growth stages neighbouring floating rice paddies means that floating rice crops are easily infested or infected. In particular it has been noted in Vietnam and Cambodia that FR has become vulnerable to rodents and some insect pests such as brown leaf hopper.
6.3. Yields and quality
The yields of floating rice have been low (1.2-2.0 tons/ha) historically, and have remained low across the recent times of the introduction of HYV rice. It is not attractive to farmers to return to floating rice for those farmers who have already converted to HYV rice in some localities (Box 4).

Box 4: Short-term high yield rice in Vietnam’s Mekong Delta

A farmer in Cho Moi district of An Giang province of the MRD claimed that most farmers in their village prefer high yields. While they want to produce rice with high yields, they do not think about the costs and benefits of such intensive rice production. In particular, farmers cultivated three crops of short-term rice a year to achieve a large annual output of rice, but the net income of three crops can be very low. Farmers may get a negative return for the summer-autumn crop because the agronomic input costs are high, but the yield and price are low at that time of year.

Source: In-depth interview with a farmer in Cho Moi district on 17 May 2016

Along with low yields, the quality of floating rice seed is perceived to be poor. It has not undergone the intensive breeding and selection processes that have produced HYV varieties. Considerable research and extension effort would be needed to get floating rice varieties available to farmers across the LMB that maximised yields for the input regime used including selection for fertiliser response, selected varieties that allowed for growing season elongation responses that could cope with highly variable water levels. Further, such varieties need to be selected for milling quality and palatability in the market to be able to compete with HYV rice.

6.4 Market development
Farmer, consumer and market perceptions of floating rice are a major barrier to the development of markets that can enable commercialisation of the commodity. Many farmers grow floating rice for home consumption or sale to neighbours and very specialised urban markets. In Vietnam, the formal market is developing through a network of nutritional rice markets in Long Xuyen City, Can Tho City, and Ho Chi Minh City. In 2015, the sale price of floating paddy rice in the MRD ranged from VND 12,000 to VND17,000 which is more than three times that of regular HYV white rice [IR50404]. In Cambodia, besides home consumption, FR is sold to middle men who buy rice in local communities for on-selling to urban markets including Vietnam. The price of floating paddy rice in Cambodia is lower than the HYV white rice such as IR50404. As noted before, in Myanmar, floating rice is grown as animal feed. Such specialised and disparate markets are vulnerable to any large fluctuations in supply and price. Also given the perception that floating rice is ‘hard’, both to eat and to mill, and the younger consumer preference for soft white rice FR has substantial barriers in market development.

In Vietnam, prior to the RCDC project for the recovery of FR in the MRD, FR farmers sold their product to customers through traditional word of mouth channels. Consequently, very few consumers knew of the existence of a regional market for FR. Most believed it had disappeared. The RCDC project included new marketing systems for FR via provincial television, national
workshops, newspaper articles, and through the floating rice festival. These avenues have successfully raise awareness of the product, increased its demand and helped it achieve commercial viability for farmers.

6.5 Cultural issues
Cultural issues around land use remain major barriers to changes to floating rice systems that would enable them to compete in economic terms with HYV rice. In Cambodia, after floating rice is harvested, the pasture land is used for grazing water buffaloes as a common pool resource. If the floating rice fields are rotated with dry seasonal crops, the pasture land is lost to grazing. Alternatively water buffaloes may damage dry season crops. These losses affect many involved in more traditional livelihoods, not just the farmers growing the FR crop, and may become a source of social conflict.
In Vietnam, almost all the former floating rice areas were converted to short-term rice such that farmers have lost their local traditional knowledge of floating rice farming. Returning to FR cropping will require training programs for farmers.
In Myanmar, people do not eat floating rice, so consumption behaviour change will be required if floating rice is to be marketed as human food.
7. Opportunities for research and extension

7.1 Vietnam
In Vietnam’s Mekong Delta, the provincial governments of An Giang, Dong Thap and Long An provinces have commitment to allocating land and support services to floating rice conservation in a plan to be implemented through to 2030.

The proposed research and extension of FR is based on the success to date of the current floating rice recovery project in the MRD. The new research will be carried in collaboration with local researchers, farmers, private sectors and decision makers in each country. A participatory co-design research and development processes will be employed to include stakeholders into the decision-making processes. Provincial and local governments, local communities and farmers will be engaged in this project from the design (inception workshop) and in piloting farming systems to ensure that they will shape, own and use the research findings in ongoing agricultural practices and policies.

7.2 Cambodia
In Cambodia, the Green Growth Program and Ministry of Environment, Department of Fisheries and Department of Agriculture in Kampong Thom province are committed to engage in a project to maintain the existing cultivated areas of floating rice. Other provinces have indicated interest in further extension of the project outcomes. These agencies are keen to promote chemical free floating rice, recovery fisheries, maintain pasture-livestock systems, and test new floating rice-dry season crops as alternative income sources for small-scale households.

7.3 Myanmar
In Myanmar, the Ministry of Agriculture, Livestock, and Irrigation and its Department of Agricultural Research and Department of Agriculture are committed to engage in the project. They are keen to select high quality floating rice seeds, promote chemical free, low-medium GI floating rice, and develop dry season crops systems on the floating rice fields as alternative income sources for improving the economic viability of FR systems and reducing rural poverty.

Additionally, rice researchers in Myanmar noted that they need a floating rice variety that can elongate more than 50 centimetres/day. They expected to exchange floating rice seed from Tonle Sap Lake of Cambodia where rice can elongate very well. Therefore, community seed selection and genetic exchange is one of the key components for conserving floating rice systems. The proposed research expects the each country can select two suitable floating rice varieties that adapt well to abnormal floods and meet consumer demands.

By involving decision makers, local scientists and farmers into the research process, the commitment to continue this activity after the project is completed becomes more likely. The research findings will provide place-based evidence for policy implementation drawing on local resources in each country.
7.4 Mekong Region

With the involvement of research partners in Cambodia, Myanmar, and Vietnam, the project will continue to develop with the engagement of local researchers and farmers. On-going research and development outreach will be fostered by cooperation among local scientists and farmers and other stakeholders.

Researchers from RCRD purified the floating rice seeds for commercial purposes because consumers still perceive it is hard to eat compare to Jasmine rice. This process of purification research continues. RCRD needs more time and resources to do this important task.

The niche informal and formal market in Vietnam is well developed with the involvement of floating rice farmers, local consumers and business sectors, and we expect to develop similar market drivers in Cambodia and Myanmar. Local government will play a key role in supporting farmers to maintain their floating rice farming practices. Local scientists will help to monitor and provide feedback to enhance these systems.

The indicators for the evaluation of this extended program would include changes in: household income, access to nutritional foods, diversity of farming practices, the diversity of flora and fauna species, soil and water and the role of women.

More importantly, national and local governments in each country are committed to supporting further research and extension activity for the maintenance and restoration of floating rice systems. In Vietnam, the integrated floating rice based farming systems are identified as important alternative livelihoods for those living with floods whilst also recovering traditional cultures, farming systems, maintaining soil fertility and water quality, biodiversity protection and adaptation to climate change. In Cambodia, maintaining the traditional cultural practices of the floating rice-pasture systems are seen as essential to restoring ecosystem services, preserving the health and well-being of local people through improving rural livelihoods and access to high quality nutritional foods such as fish and other aquatic animals.. In Myanmar, although the value of FR is low and farmers are not maximizing the ecosystems services provided by floating rice systems, there is substantial recognition of the value of FR and support for its improvement. Further research on integrated floating rice based dry season crop systems and markets for floating rice are essential.
8. Summary

This study aimed to ascertain: a) the extent and location of remaining floating rice cultivation, b) the perceived benefits and costs of floating rice, c) any issues for maintaining and expanding floating rice systems, d) the commitment of government and other stakeholders to engage in a further floating rice research program, and e) priorities for such a research program. Summary results for each item are set out below:

8.1 The extent and location of remaining floating rice cultivation
Table 5 sets out the remaining FR areas and their country of location as at 2015. Myanmar contains 94% of the remaining FR cropping area across the three countries with Cambodia having almost all of the remaining 6% with only a vestige in Vietnam.

Table 5: Remaining Floating Rice Areas - 2015

<table>
<thead>
<tr>
<th>Country</th>
<th>2015</th>
<th>% Loss 1990-2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vietnam MRD</td>
<td>200</td>
<td>99.9</td>
</tr>
<tr>
<td>Cambodia</td>
<td>46,759</td>
<td>88.6</td>
</tr>
<tr>
<td>Myanmar</td>
<td>745,037</td>
<td>41.8</td>
</tr>
<tr>
<td>Total</td>
<td>791,996</td>
<td>65.0</td>
</tr>
</tbody>
</table>

8.2 The perceived benefits and costs of floating rice
The perceived benefits of FR include:
   i) Better farmer and consumer health and nutrition
   ii) Better farmer livelihood returns from integrated FR systems
   iii) Improved farm system response to changing hydraulic regimes
   iv) Maintenance and improvement of fish and OAA catch from rice field dominated floodplains
   v) Better agroecosystem health
   vi) Increased biodiversity
   vii) Improved soil and water quality
   viii) Preservation and maintenance of traditional farming landscapes
   ix) Preservation and maintenance of traditional livelihoods and cultural practices
   x) Potential for local and regional poverty reduction through diversified livelihood activities

The perceived costs of FR include:
   i) Loss of gross volume of rice production per unit area of paddy per year
   ii) Potential reduction of national rice yield targets for export trade
   iii) Perceived loss of farmer income
   iv) Poor processing and eating quality of current FR varieties
   v) Poor marketability and commercial prospects for the FR industry.
8.3 Issues for maintaining and expanding floating rice systems

Issues for maintaining and expanding FR areas are:

i) Direction of current national agricultural development and food security policies;

ii) Investment in, and policy direction of, current and future water resource development plans throughout the Greater Mekong Region including the large scale development of hydropower dams, managed irrigation schemes, flood prevention works and dike compartment construction;

iii) Farmer perceptions of maximising yield as a measure of farming success;

iv) Poor farmer knowledge of FR farming systems;

v) Lack of improved FR varieties and the need for substantial investment in FR seed selection and breeding for better farming and consumer outcomes;

vi) Newer, younger consumer perceptions of the difficulties in processing and eating FR;

vii) Lack of developed infrastructure and markets for FR.

8.4 The commitment of government and other stakeholders to engage in a further floating rice research program

There is active commitment by farmers, local stakeholders, and government agencies at all levels to initiate or further develop FR research and extension programs across the three countries.

8.5 Priorities for such a research program

i) Establishment of FR working groups at local levels to further FR research and extension

ii) Establishment of working examples of integrated FR farming and dry season cropping systems

iii) Research projects that establish the costs and benefits of FR cropping systems at the farm level

iv) Research projects that establish the costs and benefits of FR systems on ecosystem services and biodiversity conservation.

v) Establishment of FR seed selection, exchange and breeding programs

vi) Establishment of working groups for high value FR products and their marketing.

This pilot project aimed to assess the extent and usefulness of floating rice farming systems in the rapidly developing agricultural sectors of the Lower Mekong Region. The project has established that while large areas of floating rice are still extent in Cambodia and Myanmar. While Vietnam had almost eliminated this form of rice cropping, it is now involved in dedicated programs to revive the industry. This revival and the extent of support for maintaining and developing FR in Cambodia and Myanmar indicate the importance that this farming system has for the health and wellbeing of the farming systems and populations of the LMR
Acknowledgements

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