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Research paper

Wild harvest: distribution and diversity of wild food plants in rice ecosystems of Northeast Thailand

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ABSTRACT

Rice fields provide not only a staple food but are also bio-diverse and multi-functional ecosystems. Wild food plants are important elements of biodiversity in rice fields and are critical components to the subsistence of poor farmers. The spatial and seasonal distribution of wild food plants were analysed across different sub-systems occurring within paddy ecosystems in two adjacent rice farming villages in Kalasin, Northeast Thailand. Data were collected in 102 sampling sites corresponding to seven sub-systems including tree rows, mounds, field margins, shelters, ponds, pond margins and levees. Frequency of occurrence and absolute abundance were quantified for each species in the two seasons of two years, and data on uses of wild food plant species were collected through focus group discussions. A total of 42 species from 28 botanical families were reported, and one third of these have been classified as weeds of rice by other authors. Results show that species abundance, frequency of occurrence and diversity varied seasonally and spatially within paddy rice ecosystems. Higher diversity indexes were observed in the monsoon in most sub-systems. The most diverse sub-systems in the monsoon were shelters, mounds and pond margins, and tree rows and mounds in the dry season. Field margins, ponds and levees presented lower diversity, but are habitat of aquatic species important for the local diet, such as *Ipomoea aquatica* and *Marsilea crenata*. The herbs *Lobelia* sp. and *Glinus oppositifolius*, classified as rice weeds, were most abundant species in the dry season and frequently consumed. *Leucaena leucocephala*, of which the roots, leaves and fruits are commonly consumed as vegetable, was the most abundant tree in most sub-systems. More than half of the species were specific to one or two sub-systems due to particular niche requirements. Three quarters of wild food plant species had additional uses besides food; with ten different types of use and multiple use categories occurring in the different sub-systems. This study highlights that the development of more productive lowland rice systems may jeopardize the diversity of wild food plant species in the rice landscape, which is important for the food security of the rural poor.

1. Introduction

Rice is harvested on more than 158 million ha in the world each year and growing it is the largest use of agricultural land in Asia, where 90% of the world's rice is produced [1]. In the less favourable rice environments in Asia, approximately 80 million families rely on rice production on small land holdings with low yields, and these households are among the poorest in the world [2]. The majority of rice fields are at least temporarily flooded, and though variable, these offer multiple habitats for a diverse range of organisms [3]. In this way, rice fields are often regarded as bio-diverse [3,4] and multi-functional [5,6] agro-ecosystems, providing ecosystem services and commodities indispensable for the poor [7,8]. For instance, Halwart and Bartley [9] reported the existence of over 100 different useful aquatic species growing in rice fields. Studies on the useful biodiversity of rice ecosystems are scarce [4,10] however and their ecological characterization remains a significant challenge [11].

Wild foods gathered from paddies constitute a major source of food and nutrients for impoverished rural communities, particularly in Asia, where farmers consume rice as staple accompanied by wild food plants (fruits and vegetables), fish, insects, crabs, snails and frogs, among other organisms [3]. The importance of wild

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plants from rice-based ecosystems for food and nutrition has, in particular, been recognized in Thailand [12,13], Laos [14,15], Vietnam [16], Cambodia [17], China [18] and the Philippines [19]. The term "wild" does not always imply the absence of management. Farmers might cultivate *in situ* or *ex situ*, protect, tolerate and/or promote some wild plant species, which does not necessarily imply that a species is domesticated [20–22]. Harris [23] and Wiersum [24] explain the interactions between people and plants in a continuum of management intensity that varies in space and time. Accordingly, wild food plants exist on a continuum from truly wild (absence of management) to wild protected, cultivated and semi-domesticated species, excluding locally domesticated plants. A species might be managed differently in different regions, for example, a species that is cultivated and protected in one place might not be managed at all in another. In an ethnobotanical approach, wild food plants are regarded as 'wild' and 'edible' based on local cognitive systems and according to a socio-cultural group's interpretation of the environment [25,26]. In this way, Michon and De Foresta [27] argued that species classified as 'wild' in one place do not necessarily match those species categorised as 'wild' in other places.

Wild plants growing in rice fields are scattered throughout the agro-ecosystem resulting in a 'mosaic of rapidly changing ecotones' [4: 6] and reflecting the diverse aquatic, semi-aquatic and terrestrial habitats [28,29]. The presence of different sub-systems within rice ecosystems supports the availability of a wide diversity of useful species with varying environmental and management requirements. Similarly, wild plant communities differ for each of these habitats [30]. The spatial distribution of wild plants within rice ecosystems has been described by few authors, with case studies only from Lao PDR. A study in Lao by Kosaka et al. [31] compared tree species composition and distribution in and around rice fields, and further the diversity of plants (species richness, diversity and dominance) in relation to different types of rice fields and agricultural practices [32]. Further, Natuhara et al. [33] presented an inventory of useful trees growing in rice fields in three villages in Champasak. In addition, Kosaka et al. [15] recorded the wild edible herbs occurring in rice plots in Houaphan using mean species coverage and a qualitative scale of species abundance. These studies, however, did not analyse the spatial variation within rice ecosystems in relation to quantified wild food plant species abundance and diversity.

The availability of wild foods from rice fields also varies with the season [3]. Seasonality is certainly important for wild food plant provision; for instance, the findings of a study conducted in Northeast Thailand by Cruz-Garcia and Price [12] showed that wild food plant gathering from rice paddies was intrinsically related to the agricultural activities conducted in these fields, which were also aligned to the different seasons. In addition, they reported that gathering was particularly important during "lean months", especially for the most vulnerable households. Studies on the seasonal variation of wild food plant species composition within rice fields are extremely rare. The study conducted by Kosaka et al. [15] in Houaphan is an exception; however, it did not compare species abundance and diversity in sub-systems of rice fields across seasons.

While the importance of rice ecosystems for food security and the maintenance of biodiversity has been emphasized by the International Rice Commission [34] and recognized in various Asian countries [12,15–19], the role of paddy fields in the provision of wild foods is underestimated and undervalued [4,9,11,35]. Moreover, agricultural scientists may classify as weeds that compete with rice and need to be eradicated the same plant species that are considered wild food plants by local farmers [4,30,36], consequently most research on wild plant diversity in paddies is focused on weed management. In addition, as explained in the previous paragraphs, little attention has been given towards understanding the spatial and seasonal configuration of rice ecosystems. Such analysis is necessary, as the distribution of wild food plants within rice ecosystems will affect their availability for household consumption throughout the year [3].

This paper documents the spatial distribution and seasonal diversity of wild food plants in paddy rice ecosystems in two adjacent rice farming villages in Kalasin, Northeast Thailand, where wild food plants gathered from paddy fields are crucial for household food security [12,13,37,38]. The underlying hypotheses are that the distribution of wild food plants varies spatially and seasonally among different sub-systems comprised within rice ecosystems, and multiple categories of wild food plant use occur in different sub-systems. To test these, we (a) quantified the seasonal abundance and frequency of occurrence of wild food plants in different sub-systems of rice ecosystems, (b) compared the botanical diversity of different sub-systems using diversity indices and rank abundance curves, and (c) quantified the multiple uses of wild food plant species with respect to the sub-systems in which they grow.

2. Methods

2.1. Study site

Northeast Thailand is geographically defined by the Korat Plateau that is a flat shallow depression with dispersed ponds and swamps [39]. By 2008, the region had the lowest percentage of remaining forest in the country, corresponding to 16% of the total area [40], with natural vegetation largely consisting of dry dipterocarp forest [41]. Soils are commonly heavily leached fine sandy loams, highly saline and poorly drained, with low quantities of organic matter, phosphates and nitrogen [39]. Soils are either alfisols or inceptisols [see 42].

Northeast Thailand has a Tropical Savannah climate (Köppen 'Aw') with the annual monsoon from the southwest from May to October, and a dry season from November to April comprising a cool and a hot period [43,44]. Meteorological data were obtained from Kamalasai station in Kalasin Province which is near the research area; for the complete data set: starting November 2007 (dry season) to October 2009 (end of monsoon), see Appendix 1.

The Northeast is the poorest yet largest region of Thailand [45] and one of the country's main agricultural regions, with 94% of inhabitants living in the rural areas. Rice is the main crop and is grown on 70% of the arable land [46]. Rain-fed rice is usually transplanted, and glutinous (sticky) varieties are a dietary staple and significant source of income. Glutinous rice is eaten accompanied by wild foods [3]. In the dry season, if irrigation water is available, farmers grow direct seeded rice, mushrooms or vegetables; without access to irrigation, no crops are grown.

Wild food plants, including fruits and vegetables, are critical components for the subsistence of farmers in Northeast Thailand, where they gather these plants from rice fields, home gardens, secondary forests, roadsides and swamps [12,13,37,47,48]. Plants gathered in the rice fields of Northeast Thailand have different food uses, such as *Senna siamea* (Lam.) Irwin & Barneby for making a type of curry sauce [7], *Azadirachta indica* A. Juss. as a vegetable [41] and *Irvingia malayana* Oliver as a source of oil [49]. Research in the studied villages found that all interviewed households (n = 40, or 30% of the population) gathered wild food plants from rice fields and 70% of all species gathered (n = 50) were obtained from these ecosystems [12]. In addition, a study conducted with the same households on the human-induced movement of wild food planting material in the farming landscape [50] documented that 20 plant species are transplanted to rice fields, and that the planting material of 59% of all transplanted wild food plant species was taken from rice fields. This illustrates that local households are actively ensuring

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