

## CHAPTER 13

# **Development of traditional rice varieties and on-farm management of varietal diversity in Laos**

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Present-day cultivated cereal crops have evolved from their wild relatives through natural selection of spontaneously occurring mutations, migration, and recombination of genetic variation (Harlan et al 1973). Cultivated crop varieties, often called landraces, primitive varieties, and farmers' varieties or traditional varieties, differ from their wild relatives mainly in relation to the nonshattering nature of physiologically mature grain, which has facilitated the harvesting of ripe grain for human consumption and animal feed. Farmers have, in turn, undertaken further selection within the naturally occurring variability to develop varieties that are suited to the prevailing agroclimatic conditions, provide stable yield and give varying taste, and possess a range of other associated characteristics desired by both the growers and consumers of these crops (Ford-Lloyd and Jackson 1986, Brush and Meng 1998, Harlan 2002). Though there is an awareness of the numerous traditional varieties of crop plants that have evolved over centuries through natural and human selection, records are relatively few of examples of the history of the development of varieties by farmers in any crop.

During the course of rice germplasm collecting missions undertaken from 1995 to 2000 in the Lao People's Democratic Republic (Laos) jointly by the Lao Ministry of Agriculture and Forestry (MAF) and the International Rice Research Institute (IRRI), many farmers were encountered who were able to describe the history of development of some of the varieties for which seed samples had been collected for conservation and use (Appa Rao et al 1997). This information was documented as far as was practicable, within the context of the program of germplasm collecting. The history of the varieties developed and the methods followed to develop them or select for special traits are fascinating in their own right and provide examples of the uniqueness of the indigenous farmers' knowledge that exists in many parts of Laos. It is expected that this knowledge might be lost if not documented, as agricultural practices are quickly changing with development throughout the country. Although the origin of the varieties described has been relatively recent, the records provide an insight into the way new varieties are identified and developed. The records also help document examples of the rationale used by Lao farmers when selecting the unique names for varieties that are described separately in Chapter 10.

In addition to collecting information from areas where the varieties were being grown at the time of germplasm collecting, all of the varieties described in this chapter were also grown and studied in the 1999 wet season at the National Agricultural Research Center near the capital, Vientiane. The purpose of growing the varieties under experimental conditions was to properly characterize and validate many of their attributes. In addition to documenting the history of a number of Lao traditional rice varieties, this chapter also describes how Lao farmers generally manage diversity and maintain these and other varieties in both lowland and upland situations.

### The farmers' research environment

During the cropping season, Lao farmers build a small rest-house near the fields they cultivate. They use this rest-house as a base during the cropping season, tending their crops until the produce is harvested, threshed, transported, and stored in granaries in or near their villages. This intimate involvement with all growth stages of the crop provides farmers with an opportunity to observe varieties very closely as they grow. Farmers develop an intimate knowledge of each variety and its unique characteristics, based on which individual varieties are identified. Any plants that express differences in traits relative to those regarded as normal for any variety are usually quickly noted and special care is often taken of such plants, with their growth being closely monitored to maturity. Farmers often select such distinct morphological variants and then harvest, dry, thresh, and store them separately. The variants are then often planted separately in the following season, with careful observations being made in small plots for their morphological and other agronomic characteristics, to evaluate their potential for further multiplication and subsequent identification as a new variety to which is assigned a new variety name that often reflects some aspect of the history of the variety (Appa Rao et al 2002a,b). In this process of evaluation and assessment of variants, farmers apply their own criteria. Sometimes farmers deliberately look for variants that are needed to meet specific requirements or alleviate particular production constraints or because a variant possesses unique morphological traits that are a curiosity.

### The origins of selected traditional Lao varieties

#### ***Khao ko diaw* (single-hill rice)**

Variety *Khao ko diaw* (single-hill rice) is a lowland glutinous variety that was reportedly developed through pure-line selection by a farmer (Mr. Sulan) in Pakuvai village in Xaibothong District of Khammouane Province in the Mekong River Valley. As reported by his family members, Mr. Sulan found a single rice hill growing in a shallow pond near his field in 1986. Mature seeds of that single hill were selected and tested in subsequent years. Satisfied with the grain yield and grain quality, the family then multiplied the seed and starting growing it as one of their regular varieties. Neighbors in the same village were also impressed with the variety and started growing it. It was later adopted by farmers in other villages in the same area. At the time of first noticing the variant, Mr. Sulan was impressed with the morphological characters in the single

hill he selected for testing; he subsequently named it as *Khao ko diaw* (single-hill rice) and started growing it. This variety is characterized by profuse tillering and synchronous flowering and maturity, and it possesses many large, attractive drooping panicles and large grain free of any disease and insect damage.

When grown under experimental conditions in Vientiane Municipality, the variety was characterized by producing many tillers (up to 15), possessing long drooping panicles on maturity. The grains are large, well filled, and heavy. It has a maturity time of about 150 days. Like almost all traditional varieties, it is photoperiod-sensitive. It is adapted to being grown under conditions of minimum inputs. Many farmers grow this variety in an isolated area in and around Xaibothong District of Khammouane.

*Khao ko diaw* could have originated because of segregation from a spontaneous intervarietal hybrid. As rainfed lowland farmers in the Xaibothong area grow several varieties together in small adjacent plots, a spontaneous intervarietal hybrid between two cultivated varieties might have occurred and a more vigorous recombinant might have arisen with the preferred combination of characters. A second possibility is that of a spontaneous interspecific hybrid between cultivated and wild rice. In the same general area, *Oryza rufipogon* and *O. nivara* grow abundantly and flower at the same time as some of the cultivated forms (Appa Rao et al 1997). A spontaneous interspecific hybrid between cultivated and wild rice might have occurred and subsequently segregated. The interspecific hybrid must have been more vigorous to be able to compete with other weeds, and wild and intermediate forms of rice, gradually becoming a nonshattering type and losing its awns because of recombination and natural selection. It must have survived some environmental stress, whereas other segregating plants were lost as they could not survive and establish. This unique recombinant might have reached the pond where it was found through flowing water. A third possibility is that seeds of a cultivated form might have been transported from elsewhere through floodwater, animals, or birds. It might have established in the pond where it attracted the farmer's attention (and he subsequently selected it), as it differs morphologically from other locally grown varieties in the same area.

### ***Khao phae dam* (tillering black rice)**

Variety *Khao phae dam* (tillering black rice) was developed by Ms. Lasoy (Photo 13.1) of Muang La District in Oudomxay in northern Laos; the variety was developed from another upland variety, *Khao phae deng* (tillering red rice), which is a medium-maturing glutinous variety. When she grew *Phae deng* in 1997 on an area of about 1,500 m<sup>2</sup>, she found five panicles, which were lax and longer than the rest, and spikelets that were larger with black (purple) glumes and for which the brown rice was longer, white, shiny, and attractive. The original variety, *Phae deng*, produces grain with red glumes. According to Ms. Lasoy, as there were no other varieties with such black glumes and attractive grain characteristics, she grew it in 1998 to further test it, and then multiplied its seeds. Impressed by its novelty, she started cultivating it on a regular basis. In turn, her neighbors obtained seed of the variety and started growing it as a new variety, which was not found in other nearby villages.

### ***Khao hom do* (aromatic early-maturing rice)**

In 1984, a farmer (Mr. Bee, Photo 13.2) in the village of Sine-Sai in Bounthai District of Phongsaly in northern Laos obtained seeds of the lowland glutinous variety *Khao hom kang* (aromatic medium-maturity rice) from a neighboring village. When he grew this variety in his own village, he found some plants that flowered and matured a month earlier than the original variety (which matures in about 4 months). He harvested all the early-maturing panicles, bulked them, and grew the seed the following year. After testing in subsequent years, he found the selection to be superior to the original variety in relation to several characters, but particularly for early maturity, a character that he had been looking for. As claimed by Mr. Bee, *Khao hom do* matures in 90 days (30 days earlier than *Khao hom kang*), produces dark green leaves and larger and longer panicles, and is higher yielding than the original variety. The grain is more aromatic, with good eating quality. Because of its early maturity, aroma, and other desirable characters, the new variety quickly spread among farmers in the village and then to neighboring villages, becoming very popular in the district within a relatively short time.

The early-maturing plants that formed the basis for the new variety, *Khao hom do*, might have arisen as a spontaneous mutation, or the seeds Mr. Bee grew initially might have been a physical mixture of early- and medium-maturing varieties, both of which were aromatic, allowing him to select and later multiply the shorter earlier-maturing plants.

### ***Khao keut* (created or born rice)**

Variety *Khao keut* (created or born rice) was developed in 1993 by Mr. Khamphet, a farmer from Hin village in Kham District of Xieng Khouang in northeastern Laos. It was developed from a traditional variety called *Khao bong* (bamboo rice), whose culms are thick, strong, and long, resembling those of bamboo. When Mr. Khamphet grew the locally popular variety *Khao bong*, he found five plants that differed from those of the original variety. The variant plants were taller and produced large, long, and loose panicles. These off-type panicles were selected by Mr. Khamphet, with the seeds being kept separately for further testing in the following year, when it was found that they produced plants that were superior to the original variety. On cooking, it was also found that the grain of the new plants was soft and had very good eating quality. Mr. Khamphet and other farmers in the village then started growing the new variety on a regular basis, naming it *Khao keut* (created or born rice). Both the original variety, *Khao bong*, and the newly developed variety, *Khao keut*, are rainfed lowland glutinous varieties that are transplanted twice during the cropping cycle (a practice in some lowland areas of northern Laos) and mature in about 5 months. The off-type panicles that formed the basis of the selection for the new variety, *Khao keut*, might have arisen as a spontaneous mutation or segregation from a spontaneous intervarietal cross, with the segregating plants being subsequently easily noticed as a result of being conspicuous by their height and loose panicles.

### ***Khao pong deng* (regenerated red rice)**

Variety *Khao pong deng* was developed in Ban Song village in Khun District of Xieng Khouang in northeastern Laos. Floods are very common in this area and can sometimes completely submerge and destroy the rice crop. During one such season of prolonged flooding, when almost the entire rice crop in the area was destroyed, a single plant was found in an otherwise destroyed rice field, and it survived to produce some grain. The farmer who found the plant, believing it to be a significant omen, gave the rice seeds that were produced to a local monk, who then multiplied the seed, testing the plants under field conditions, and subsequently distributed the seed to local farmers. The variety was named *Khao pong deng* (regenerated red rice) to reflect the belief that it was the regeneration of the rice destroyed by the flood.

A second version of the story relates to the origins of the variety. This version says that a local farmer found a single rice plant that had survived the flood and was growing in a local forest. Believing that plant had been created by “the spirits,” the farmer gave it to the village monk, who grew it, multiplied the seed, and distributed the seed to local farmers. Variety *Khao pong deng* grows very tall, tolerates submergence for a considerable time, is late maturing, and has glutinous endosperm. Probably the single plant that was the basis of the variety was a spontaneous mutant that has the ability to regenerate, but the trait was expressed only when the flood stress was imposed, enabling it to express its unique capacity for regeneration.

### ***Khao khen sua* (shirt-sleeve rice)**

Variety *Khao khen sua* was introduced to Pek District of Xieng Khouang (in northeastern Laos) from Khun District in the same province during the early 1950s. A farmer from Pek, when visiting a farmer’s field in Khun, selected an attractive panicle from the latter’s rice field and hid it in his shirt sleeve for the trip back to his own village. On the return journey, the farmer reportedly encountered a French soldier, who shot him. The injured farmer was able to reach the provincial capital, Phonesavan, where he died. Following his death, an old woman noticed the rice panicle hidden in the sleeve of the farmer’s shirt. Believing it to be of significance, she took the panicle to her own home, where she kept the seeds and grew them the following season. The woman noted several attractive attributes in the resulting plants, whereupon she further multiplied the seed and distributed some to other households in the village. The resulting variety was given the name *Khao khen sua* (shirt-sleeve rice) to reflect where the woman had obtained the panicle on which the variety was based. Following extensive farmer-to-farmer and village-to-village exchange, the variety is currently widely grown in Pek District of Xieng Khouang. It is a medium-maturity glutinous variety grown under wet-season lowland conditions.

### ***Khao bong do* (early bamboo rice)**

In the 1960s, a farmer from Nambak District in Luang Prabang in northern Laos visited Xieng Khouang in the northeastern part of the country. During the visit, he saw variety *Khao bong* (bamboo rice) growing in a field and, being impressed by it, took a small quantity of seed with him on his return to Nambak. The variety was

evaluated in Nambak and then multiplied, with seed being distributed among other households and villages. It became known as *Khao bong do* (early-maturing bamboo rice). When grown in Nambak, it was reported to mature in 4 months, 1 month earlier than when grown in Xieng Khouang. Farmers reported that it matures 1 month earlier in Nambak than in Xieng Khouang; it was also reported to have larger panicles with well-filled heavy grains when cultivated in Nambak. The earlier maturity when grown in Nambak could have one or more reasons. In Xieng Khouang, this variety is usually grown following a double transplanting practice that is sometimes adopted in northern Laos, whereas in Nambak a single transplanting is adopted. However, the more likely reason is an effect of temperature on maturity time. The area of Xieng Khouang where the variety is grown has an elevation of about 900 m, compared with an elevation of about 350 m for Nambak. The higher elevation in Xieng Khouang is probably associated with significantly lower temperatures in the latter part of the growing season, relative to Nambak, thereby extending the maturity time of most rice varieties. This phenomenon is often observed when varieties developed for the main rice-growing areas in the Mekong River Valley are grown in some areas of northern Laos (Schiller et al 2001). *Khao bong do* has become popular in the Nambak area, not only on account of its relatively early maturity but also because of the ease with which it can be threshed combined with its glabrous leaves, which allow farmers to handle it easily during weeding, harvesting, and threshing. In Nambak and surrounding areas, it is also known as *Khao Xieng Khouang do* (Xieng Khouang early rice).

### ***Khao kai noi* (small chicken rice)**

This variety was first introduced to the northern Lao province of Houaphanh from neighboring Vietnam, and later introduced to Xieng Khouang to the south of Houaphanh. It is currently grown extensively in both Houaphanh and Xieng Khouang. There are different suggested origins for the naming of *Khao kai noi* (small chicken rice). One belief is that it was so named on account of its small grain size, small enough to allow it to be fed to chickens without first being ground or broken. Others attribute the name to the perception that, if the grain is broken in the process of dehulling, the broken pieces of grain are so small as to have little use, even for feeding chickens. A further story about the origin of the name (and the variety) is that a woman in Seula Province of Vietnam found undigested rice grains in the gullet of a chicken. As the grains were small and globular, and differed considerably from the existing varieties, it aroused her curiosity and she then grew plants from these undigested grains. After further seed multiplication, the resulting crop was regarded as having good yield potential, a very high milling recovery, and good eating quality.

*Khao kai noi* is a rainfed lowland, glutinous, late-maturing rice variety. The grain is strikingly different from that of most other varieties, being short, rounded, and almost globular in shape. The unique feature of the variety is its high milling recovery (about 80%, compared with about 65% for most other varieties). The grain is nonshattering and is difficult to thresh. However, despite this difficulty, it is very highly regarded for its aromatic character and excellent eating quality, on account of which it is sometimes eaten alone without the usual side-dishes. It was reported to be

**Table 1. Variant forms of variety Khao kai noi (small chicken rice) and source of collection.**

Lao name of variant	English name equivalent	Character	Source of sample	
			Province	Ecosystem
<i>Khao kay noi</i>	Small chicken rice	Standard variety	Northern region	Lowland
<i>Khao kay noi dam</i>	Black small chicken rice	Black glumes	Houaphanh	Lowland
<i>Khao kay noi deng</i>	Red small chicken rice	Red glumes	Houaphanh	Lowland
<i>Khao kay noi khaw</i>	White small chicken rice	White glumes	Houaphanh	Lowland
<i>Khao kay noi leuang</i>	Yellow small chicken rice	Yellow glumes	Houaphanh	Lowland
<i>Khao kay noi lai</i>	Striped small chicken rice	Striped glumes	Houaphanh	Lowland
<i>Khao kay noi hai</i>	Upland small chicken rice	Adapted to upland environment	Houaphanh	Upland
<i>Khao kay noi hom</i>	Aromatic small chicken rice	Aromatic	Houaphanh	Lowland
<i>Khao kay noi hang</i>	Awned small chicken rice	Awned spikelets	Xieng Khouang	Lowland
<i>Khao kay noi/nam yen</i>	Cold (water)-tolerant small chicken rice	Cold-tolerant	Houaphanh	Lowland

Source: Appa Rao et al (Chapter 10).

high yielding under the low-input conditions that prevail in most areas of Laos, with yields of 3 to 4 t ha<sup>-1</sup> in parts of Xieng Khouang in the northeast and 4–5 t ha<sup>-1</sup> in Houaphanh in northern Laos.

Based on glume color and other characteristics, nine variant forms of the variety have been identified, with some of the varieties having additional descriptions in the varietal name to reflect some characteristics (Table 1). Variety *Khao kai noi lai* (striped small chicken rice) has glumes with longitudinal red and yellow alternating stripes; *Khao kai noi leuang* (yellow small chicken rice) has yellow glumes, whereas *Khao kai noi deng* (red small chicken rice) has red glumes. *Khao kai noi hang* (awned small chicken rice) has awned spikelets. Of the nine variant forms, *Khao kai noi leuang* is regarded as being the most aromatic. The brown rice of all the variants is generally similar in appearance. In most fields, only one of the forms is grown. In gross morphology, *Khao kai noi* appears to be intermediate between the indica and tropical japonica (javanica) groups.

### **Khao poum pa (fish stomach rice)**

Variety *Khao poum pa* (fish stomach rice) was developed in Sing Sai village in Khoua District of Phongsaly in northern Laos. The origin of this variety is reported to be similar to that of *Khao kay noi*, but with *Khao poum pa* being developed in Laos from rice grains found in the stomach of a fish rather than in the stomach of a chicken as for *Khao kay noi*. The undigested grains were planted and multiplied, with the resulting crop being found to give a superior yield relative to other varieties being grown in the area. Through farmer-to-farmer and village-to-village exchange, *Khao poum pa* is now a well-known variety among farmers and villages near its area of origin in Phongsaly Province. The variety is also known as *Khao khay pa* (fish egg rice), both names reflecting the source of origin of the seed, which formed the basis of the variety.

### ***Khao holo* (holo tree rice)**

The origins of this variety were reported by farmers to have been based on a single rice plant that a local farmer found growing under a “holo” tree in the village of La Kao in Phongsaly District of Phongsaly Province, one of the most remote northern provinces of Laos. The holo tree is used by one of the ethnic groups of Phongsaly Province, the Phu Noi, as an indicator of relatively high soil fertility and a basis of selection of upland areas for rice cultivation. After seed multiplication and field testing, the single rice plant collected formed the basis of a new traditional variety, which was named *Khao holo*. This variety is still very popular in Phongsaly District where it was developed. It is an upland glutinous aromatic variety of medium maturity.

### Farmers' seed multiplication practices for maintenance of varietal purity

Lao farmers produce their own seed of traditional and recently developed modern varieties. For seed purposes, farmers in the lowland environment usually select fields where the crop is growing well, is phenotypically uniform, and, where possible, has not been stressed during growth. Mature grain to form the seed of each variety is harvested separately, bundled, and carried to the threshing floor, where the sheaves of each variety are also kept and threshed separately. After threshing, the seed of each variety is stored in separate containers. As the farmers are able to readily identify the varieties based on their seed characters, they usually do not need to label the containers in which the seed is kept.

Farmers usually rogue off-types on the threshing floor and select uniform panicles for sowing in the subsequent year. The farmers have a clear idea and mental picture of unique varietal characteristics and avoid off-types. Avoiding off-types in the process of panicle harvesting or subsequently on the threshing floor is almost equivalent to mass selection. Lowland farmers repeat the seed selection process once every three years, as they believe that varietal characteristics will be lost and new types will appear if they do not maintain a routine of seed selection.

At harvest time, during the process of panicle selection for seed purposes, upland farmers usually tie a basket around their waist and select large and attractive panicles of distinct types, which are placed in the same basket (Photo 13.3). Some highland farmers harvest panicles along with peduncles; on returning to their house, farmers usually tie the panicles into bundles, dry them in the sun, and then keep them carefully in the house, often hanging them from roof rafters, with particular care being taken to protect them from being damaged by grain moth. Some farmers (particularly those belonging to the Hmong ethnic group) keep the panicles above the kiln, where the smoke keeps away the grain moth. In some areas, the grain of selected panicles is stripped after selection, with the bulk of the panicles being left in the field.

Lao farmers, particularly in the uplands, deliberately maintain a degree of diversity within a particular landrace to provide production stability. Variable populations in upland varieties are maintained by selecting different plant and panicle types found in a single field.

## Management of varietal diversity

Enormous varietal diversity existed in Lao rice varieties before the mid-1990s (Schiller et al 2001). This diversity was largely based on the indigenous traditional varieties that had evolved over centuries within Laos, farmer-to-farmer exchange within the country, the introduction of exotic varieties by farmers from neighboring countries, and the introduction of varieties by foreign agencies and institutions (Schiller et al, Chapter 2), combined with the development of new varieties by Lao farmers. Varietal diversity in the indigenous traditional varieties has evolved and accumulated, as rice has been grown under increasingly diverse agroclimatic conditions and ecosystems, and to meet an increasing range of food quality preferences of the diverse range of ethnic groups found in many areas of Laos.

The strategies for farmer management of varietal diversity under upland and rainfed lowland conditions differ considerably. Upland farmers grow varieties that are composed of several phenotypes but that have similar height and phenology. Lowland farmers usually grow several uniform varieties of varying maturity, mainly to distribute the labor requirement, with each variety being grown in individual small plots. Growing several varieties also assists in providing greater production stability by reducing the risks of the impact of climate (mainly drought), pests, and diseases if only one or two varieties are grown. Lao farmers have an extensive and intimate knowledge of different varieties and their characteristics, adaptation, and quality attributes.

Lao rice farmers have not only maintained a wide variety of landraces, but have also continuously evaluated and improved their planting material and exchanged it with others. The tradition of farmers developing and maintaining diversity can still be found in many areas of Laos, particularly in the rainfed upland conditions of northern Laos.

The present management system has been changing fast, particularly since 1993, following the release of the first of a number of improved Lao varieties developed for the lowland environment for the main lowland rice-growing areas in the Mekong River Valley. The release of these “modern varieties” has been associated with the development of agricultural extension services, which, combined, have aimed at quickly achieving national and household rice self-sufficiency, together with improvements in individual rural household income through agricultural diversification. These initiatives have already resulted in rapid and marked changes in rice diversity throughout most of the main rice-growing areas in the Mekong River Valley. By 2000, less than 20% of the main wet-season lowland rice area in this valley was grown with traditional varieties compared with about 95% as recently as 1993, the year in which the first batch of improved Lao lowland varieties was released. Although traditional varieties continue to be used in lowland areas of northern Laos, the erosion of the remaining diversity can be expected as new higher yielding varieties are developed for these areas. Similarly, in upland areas, the diversity can also be expected to be eroded as a result of a combination of the implementation of the national policy for more sustainable agricultural practices in the uplands and the identification of upland varieties with broad adaptability.

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## Notes

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