

INDIGENOUS KNOWLEDGE AND THE DIVERSITY OF RICE VARIETIES AMONG THE TAY MINORITY IN DA BAC DISTRICT, HOA BINH PROVINCE ^(*)

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1. Introduction

Ethno-botany is a scientific field that examines the relationship between people and plants as well as the role of indigenous knowledge in conserving biological diversity. The field analyzes and evaluates information obtained from farmers and field surveys to provide guidelines for the conservation and utilization of botanical gene resources. Ethno-botanical studies can reveal information about the food preferences and needs of local people, the tendency and prospects of botanical resource utilization, and the causes of botanical gene erosion. Ethno - botanical studies also help local communities understand the importance of scientists who study resources, identify the land areas that they should access in different circumstances, and develop ways to satisfy their increasing food demands without damaging the diversity of local natural resources.

This paper focuses on the relationship between the Tay minority's indigenous knowledge and the polymorphism of rice varieties in Da Bac district, Hoa Binh province.

2. Location, materials and research methods

2.1. Location

The research on indigenous conservation of local biodiversity was

conducted in Da Bac district of Hoa Binh province. The data was gathered from the Tat village of Tan Minh commune and the Cang village of Doan Ket commune, which have representative geographic characteristics of Da Bac district, with average altitudes of 600-800 meters and a complex topography that results in different climate sub-regions. At these research sites, the Tay minority's simple agricultural practices and traditional culture play an important role in the maintenance of the diversity of local plants and plant-compositions.

2.2. Research materials

Research materials include samples of rice species collected from households in the Tat, Tan Minh commune and Cang villages, Doan Ket commune.

2.3. Research methods

This research uses PRA and RRA survey methods to collect information about the Tay minority's socio-economic conditions and their knowledge of agricultural practices and methods, breeding and seed preservation methods, and the biological and agricultural characteristics of local rice resources. Additionally, the research uses the International Rice Research Institute (IRRI) and the International Plant Genetic

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Resources Institute (IPGRI)'s grain quality and characteristic evaluation method, which identifies glutinous and regular rice based on the reaction of the rice to KI-I solution; and employs the Simpson coefficient to calculate the diversity of rice within and across species.

3. Research findings and discussions

3.1. Ethno - botanical knowledge related to the diversity of rice species in the two research locations

3.1.1 The diversity of species and species naming

Table 1: The diversity of names given to local rice species at the two research locations

Local name of species	Group	Meaning	Name derivation/root	Use
Mặc buồm/ Kháu vắn	Mountain Glutinous	Loofah fruit	Outer shape resemblance	Making steamed rice, rice pudding and pastries
Mặc cái	Mountain Glutinous	Lychee fruit	Outer shape resemblance	Making steamed rice and rice wine
Mặc có	Mountain Glutinous	Fan-palm fruit	Outer shape resemblance	Making steamed rice and funeral sacrifice
Mặc mau/ Kháu chiêm	Mountain Glutinous	<i>Nặng</i> fruit	Outer shape resemblance	Making steamed rice and rice wine
Mặc ổi	Mountain Glutinous	Guava fruit	Outer shape resemblance	Making steamed rice and rice wine
Trăm khảo	Mountain Regular	White-coated regular rice	Color of rice husk	Making regular rice, rice wine and rice vermicelli
Trăm khảm	Mountain Regular	As if gold- plated	Color of rice husk	Making regular rice, rice wine and rice vermicelli
Trăm lượng	Mountain Regular	Regular with golden husk	Color of rice husk	Making regular rice and rice wine
Trăm nành/ trăm đánh	Mountain Regular	Regular with red husk	Color of rice husk	Making regular rice and rice wine
Trăm pom	Mountain Regular	Regular, Round	Grain shape	Making regular rice and rice wine
Trăm sai	Mountain Regular	As soft as sand	Rice quality	Making regular rice and rice wine
Kháu ngân	Mountain Glutinous	As light as silver	Color of rice husk	Making steamed rice, rice pudding and pastries for special occasion
Kháu noợn	Mountain Glutinous	Maggot	Grain shape	Making steamed rice, rice pudding and pastries for special occasion

Kháu khinh/ Lưư phũn	Mountain Glutinous	Ginger - forgetting the husband	From a folk tale	Making steamed rice, rice pudding and pastries for special occasion
Phá hớ	Mountain Glutinous	From Heaven	From a folk tale	Making glutinous rice and rice wine
Vũn hũt	Mountain Glutinous	Can be removed from stalk by hand	Easy to be removed from stalk	Making steamed rice, rice pudding and pastries for special occasion
Hạng mụ	Mountain Glutinous	Pig tail	Grain has black, long hair	Making steamed rice, rice pudding and pastries for special occasion
Hạng ngua	Mountain Regular	Buffalo tail	Grain has red, long hair	Making regular rice, rice wine and rice vermicelli
Hạng đòn	Mountain Regular	White tail	Grain has white, long hair	Making regular rice and rice wine
Cai hỏc	Water Glutinous	Thick hair	Grain has thick hair	Making steamed rice, rice pudding and pastries for special occasion
Say khuyệt	Water Glutinous	Marsh frog's egg	Grain has black and white stripes	Making steamed rice, rice pudding and pastries for special occasion
Lẻch đặm/ Noọng nả	Water Glutinous	Black and hard like iron	Outer shape, rice quality	Making steamed rice, rice pudding and pastries for special occasion
Kẻ đẻ/Sa lẫng	Mountain Glutinous	Unknown	Unknown	Making glutinous rice and rice wine
Kháu nắm	Mountain Glutinous	Unknown	Unknown	Making glutinous rice and rice wine
Đặm cả	Mountain Glutinous	Black like a crow	Color of rice husk	Making glutinous rice and funeral sacrifice
Trặm hin	Water Regular	Hard like rock	Rice quality	Making regular rice and rice wine
Cẩm pi	Mountain Glutinous	Black rice	Color of grain	Making glutinous rice and funeral sacrifice
Trặm hỏm	Mountain Regular	Fragrant grain	Rice quality	Making regular rice and rice wine
Mạ giẩng	Mountain Glutinous	Hanged dog	From a folk tale	Making steamed rice, rice pudding and pastries for special occasion

Kháu mồn	Mountain Glutinous	Unknown	Unknown	Making glutinous rice and rice wine
Kháu Lào	Mountain Glutinous	Unknown	Imported from Laos	Making glutinous rice and rice wine
Kháu tới	Mountain Glutinous	Unknown	Unknown	Making steamed rice, rice pudding and pastries for special occasion
Léch lượng	Mountain Glutinous	Hard stalk, yellow husk	Outer shape	Making steamed rice, rice pudding and pastries for special occasion
Kháu buốc	Mountain Glutinous	Unknown	Unknown	Making glutinous rice and rice wine
Kháu coón	Mountain Glutinous	Thick grain	Outer shape	Making steamed rice, rice pudding and pastries for special occasion
Kháu khượng/ kháu móc	Mountain Glutinous	Difficult to remove grain from stalk	Difficult to remove grain from stalk	Making glutinous rice and rice wine

The name of the species is the first index for ascertaining the polymorphism of local rice varieties. Farmers usually name the species based on characteristics such as grain color, stalk hardness, and rice quality, or name them after the commonly-seen fruits and animals that resemble the unique shapes of grain. Additionally, some species have their name derived from popular folk tales (see Table 1).

The sample of domestic rice grown in Da Bac bears a wide variety of names. These names provide rather specific and lively descriptive details about the various types of rice. For instance, *mạc cái* (lychee) water glutinous rice has an oval-shaped grain with red inlays similar to the lychee fruit; *mạc buồm* (loofah) mountain glutinous rice has long, large grains that resemble the loofah; *đặm cả* (crow) mountain glutinous rice's husk is as black as a crow; *hạng ngựa* (buffalo tail)

mountain regular rice has grains with long and red tails like those of buffalos; and *léch đặm* (black and hard like iron) water glutinous rice has very hard stalks and yellow grains with black stripes. At the same time, the *léch đặm* rice is soft and sweet, and therefore it is also called *noọng nà* (young girl on the rice field). These examples suggest that the rice variety in Da Bac is diverse not only in types and features, but also in names.

3.1.2. The diversity of cultivation and sowing methods

- Diversity in cultivation methods

The complex topography of Da Bac gives rise to diverse cultivation and sowing methods.

+ **Highland cultivation:** This is a cultivation method of the mountainous areas and was originally a primitive form of

agriculture in the tropics. Today, this cultivation method continues to play an important role in the material and spiritual life of the Tay minority in Da Bac. The most popular plant grown in the highland is mountain rice, corn and cassava, which do not require frequent irrigation aside from natural watering. Highland cultivation consists of selecting the farming area, clearing the land by slashing and burning trees and setting them aside for fencing or fuel, and then using sticks to dig holes for sowing. Each season, the farmers pay several visits to weed the field before harvesting. Based on their farming experience, the Tay people grow the crops on different types of highland fields, which fall into two major categories:

Fixed fields: These are fields that are close to the farmers' residence (*háy sảng*) and require more investment in terms of technology and fertilizer. These fields are reserved for mountain rice species that can tolerate poor soil or plants that need frequent attention such as corn, beans and vegetables, etc.

Unfixed/shifting fields: These are fields far from the farmers' residence (*háy rấc*), and are normally utilized for several years while the soil is still fertile and abandoned permanently or temporarily when the soil has lost its nutrients. These fields are used to grow mountain rice and a number of crops such as string beans, pumpkins and winter melon. Nomadic fields can also be divided into "good" fields-which are reserved for species that have long life spans and require rich fertility - and "poor" fields - which are used for short-term crops that do not require many nutrients.

+ **Wet-rice faming:** Introduced to water rice cultivation since the early days, the Tay in Da Bac have invented various ways to bring water into their paddy fields (*âu nặm sờ na*), including finding the water source, building an irrigation system with bamboo pipes or gullies, or digging lakes and dams to water the crops. As permanent residents of Da Bac with a long history of lowland cultivation, the Tay people live in elevated or earthen houses at the mountain foot, facing the fields from a higher altitude: *Huou na inh quẩn hin/Nà kháu niêu táng na* (A mountain in the back/a glutinous rice field in the front).

Paddy fields are divided into two categories. Large, "good" fields (*nà lại, nà chấn*) are used to grow high-quality crops that require fertile soil: *Kháu noọng nà kẩn pà pín hón/Kháu say khuyết kẩn hòm khành niêu* (*noọng* water glutinous rice is served with grilled fish/the soft and fragrant *say khuyết* is served with jerked meat). *Noọng* and *say khuyết* are high-quality water glutinous rice that are usually served with local people's favorite dishes.

Small and "poor" fields are for lower-quality rice species that can grow in less fertile soil: *Kháu trặm hin nà hái cửa bé/Kháu trặm hé nà heo cửa mụ* (*hin* rice from the poor field is for the goats/*hé* rice is for the pigs).

- *Diversity in sowing methods*

The Tay in Da Bac have different sowing methods. Mountain rice can be grown either alone or combined with other plants or rice varieties in the same field, depending on the type and characteristics of the rice species, land fertility level, and household labor resources.

Table 2: Sample of rice species whose seeds can be mixed to sow in the same field

Species to be mixed	Type of rice	Husk	Maturity Period	Objective
Kháu mòn -Thượng hải	Mountain Regular	Brown inlays	Early	Early harvest
Tăng sản - Yên thế	Mountain Regular	Brown inlays	Early	Early harvest
Léch lượng - Léch đậm	Mountain Glutinous	Golden inlays - black inlays	Late	Variety
Kháu khỉnh - Lượng cộng	Mountain Glutinous	Golden smooth surface - red inlays with hair	Average	Prevent damage by birds
Kháu mòn - Kè đê	Mountain Glutinous	Brown inlays – purple inlays	Early	Early harvest
Kháu khỉnh - Kháu coón	Mountain Glutinous	Golden smooth surface - Yellow with hair	Average	Low risk
Kháu ngân - Cặm pi	Mountain Glutinous	Light golden - Black	Average - Late	Flexibility
Kháu ngân - Đặm cả	Mountain Glutinous	Light golden - Black	Average	Variety
Kháu khỉnh - Mạ giáng	Mountain Glutinous	Golden - Short hair	Average	Prevent damage by birds
Trăm nành - Trăm lượng	Mountain Regular	Light golden - Dark golden	Average	Flexibility
Mạc cái - Kháu khuyết	Water glutinous	Red inlays - Golden	Average	Flexibility
Say khuyết - Kháu khượng	Water glutinous	Black inlays - Golden	Average	Variety

Separately-grown rice crops: The majority of mountain rice species in the highland are grown separately. However, farmers also utilize the periphery of the rice fields to grow other crops such as *nho nhe* beans (*nhọ nhẹ*), string beans (*mạc thùa kháu*), pumpkins (*mạc ức*) and loofah (*mạc buôm*). These species are grown around the rice field, two meters away from each other.

This helps protect the rice crops and also serves as extra food supply.

Rice grown with other plants: Normally, mountain rice species can only grow in combination with winter melons, (*mạc tánh kháu*), cucumbers (*mạc tánh là*) and radish greens (*phắc cật*): *Mạc thùa, mạc ức, nắm liếp háy/Mạc tánh kháu váy nắm lớn cặn* (String beans and pumpkins are grown

around the field/Winter melon and rice are mixed together). At the beginning of each crop, while digging holes to sow rice seeds, farmers also sow other types of seeds at intervals. Winter melons and cucumbers are the most popular choices in Da Bac, since they have short crawling stems and few tassels. Farmers can grow other plants around the field. Therefore, each time the Tay visit their fields, they can do several things at the same time: they can gather sticks for fuel after tending the rice field, or pick vegetables to bring home for dinner. This habit is quite different from that of farmers in the lowland, hence a distinctive characteristic of highland agriculture.

Mixed rice crops: The Tay in Da Bac usually grow two or three rice species on the same plot of land. Both mountain and water rice varieties can be mixed together as long as glutinous rice is not mixed with regular rice, which are called *kháu báo xạo* (male and female rice) by the local people.

Rice species that are chosen to be mixed together (see Table 2) usually share the same maturity period and have similar height, so that they can be sowed, fertilized and harvested at the same time. The Tay usually say:

Mi đặm mi đòn măn chàng yểu

Phở nhìn phứ chai măn chàng pên.

Tu nôóc tu nự nha kìn kháu

Kháu háy, kháu nà váy lại huông.

Which means, it is only good when black and white go hand in hand/Just like male and female must be together/Birds and rats would stay away from the field/Rice in the paddies and on the mountains would

yield bumpy crop. The Tay believe that rice is the most precious treasure that the human race is endowed with. Therefore, rice varieties need to be grown in an intimate community in order to stay healthy and grow fast. Since the majority of people living in the mountainous areas are self-sufficient, they believe that intercropping could help minimize risks due to unfavorable conditions and damage by birds and rats. Additionally, growing several species in the same field would make it look like a colorful garden (*poóc mạy*).

From a technical point of view, the Tay's practice of intercropping serves to optimize usage of sunlight, soil nutrients, and moisture, as well as minimize risks. More importantly, it contributes to the accumulation of local knowledge through long-term cultivation, which helps maintain the diversity of agricultural products and provide diverse food sources for people living in the mountains.

3.1.3. Diversity in maturity period and growing seasons

The set of rice varieties in Da Bac comprises of short-term species (less than 130 days), medium-term species (130-145 days) and long-term species (over 145 days). Most mountain rice species can only be grown for one crop and rely on natural irrigation during the entire growing process. Short-term species include *kháu mòn*, *thượng hải*, medium-term *kháu khỉnh*, *mạc buôm* and long-term *mac có*, *cắm pi*. Water rice are divided into summer rice and winter rice, according to their harvesting season. Summer rice is usually grown for a long period of time and includes species that can

tolerate low temperature such as *mặc mau*, *trặm lài*. Winter rice includes some short-term regular rice such as *trặm hin*, *trặm hé* and long-term regular rice such as *léch lượng*, and *léch đặm*. Given the topography, soil components, diversity of rice varieties and availability of local human resource, people in Da Bac usually spread the crops throughout the year. This strategy helps guarantee a steady supply of labor all year round. The strategy also makes it more convenient to take care of and harvest the crops, and helps minimize loss due to unfavorable conditions. This illustrates the diversity in types, seasons and maturity periods of Da Bac local rice varieties, which corresponds to local geographical features.

3.1.4. Diversity in quality and use of cultivation products

The Tay in Da Bac grow different rice varieties not only to accommodate geographical features and availability of human resources, but also to match with their customs and lifestyles, such as those seen in their culinary tradition. A handful of pressed rice to take along to the field, a rice-filled bamboo tube, a bowl of rice pudding on Tet, a sip of rice wine by the fire, and a sacrificial ritual are a few lively examples of the organic relationship between the people and their various rice products. This relationship does not only help conserve traditional Tay culture, but also contributes to the maintenance of the local rice polymorphism.

- For daily meals

+ *Use of glutinous rice*: People living in the mountains, including the Tay in Da Bac, use glutinous rice as daily starch. They

usually steam the rice to take to work and save a portion in a *ém* (a type of container) for people at home. If someone visits a Tay family, he/she would always find some sticky rice in the *ém*. The Tay's meals are usually very simple, with sticky rice and some condiments, but no soup.

+ *Use of regular rice*: In the past, Tay people used glutinous rice primarily. However, they now also use regular rice in daily meals during the low-season or on rainy days, when they have time to make more elaborate dishes. Regular rice is also used to make wine or rice cakes; exchanged for labor during *vàng ràng*, *an ràng*, when villagers have to hire outside people to help with farm work; or exchanged for other goods.

- On special occasions

The Tay celebrate various festivals all year round. They only use glutinous rice during these festivals to make steamed rice, rice pudding, rice wine and rice cakes: *Lại đèo niệu sên nà*, *sên háy/Pên cồc*, *dạc đáy sên phị hươn* (different types of glutinous rice are used in land and field worships/The best glutinous rice is used to worship ancestors). The Tay use the whitest, tastiest and most fragrant rice (*pên cồc*) to offer to their ancestors (*pên phị hươn*) during paternal (*sên ú u*), maternal (*sên áu pó áu mé*), New Year (*sên kin sết*), and ancestral grave (*sên tề má*) worship rituals.

For rituals related to farm work (*sên hét ngai*), people use popular rice species, such as high-quality glutinous rice and red glutinous rice, as offerings. These rituals usually include *sên nà* (water paddy field worship), *sên háy* (mountain rice field

worship), *sên hùa pi* (new crop ceremony), *sên tôông* (field entrance ceremony), *sên kháu mớ* (new rice worship), and *sên hôi mùa* (end of crop ceremony). Popular rice varieties are also used during *sên nắ́m* (water source worship), *sên mì phân* (appeal for rain), and *sên đắ́y* (appeal for sun).

During these special occasions, the Tay do not use black glutinous rice and black glutinous rice wine because they believe black is an inauspicious color and should be avoided during these festivals.

- Religious purposes

The Tay believe that rice varieties with black husks, such as *kháu cắ́m* and *mắ́c có*, could drive away ghosts and other evil spirits, so that they would not interfere with the local people's businesses: *Kháu cắ́m pi cắ́m kho phỉ khỏ́i/Kháu mắ́c có cắ́m kho phỉ va* (*cắ́m pi* rice can break the mountain ghost's neck/*mắ́c có* rice can break the forest ghost's neck). Therefore, whenever the Tay travel a long distance, they always take along a handful of such rice for food and to scare off evil spirits.

Table 3. The diversity of rice genes and their use

Use	Type	Quality and characteristics	Name of species
Daily	Glutinous - Regular	Not very soft, having little or no fragrance. Used in everyday meals or in exchange for labor.	<i>Kháu mòn, kè đẻ, tắ́ng sắ́n, hắ́ng mù, hắ́ng đờn.</i>
Special occasions	Glutinous	Very soft and fragrant. Used to make steamed rice, rice cakes and rice pudding on special occasions.	<i>Kháu khỉnh, kháu tói, kháu lế́ch, cai hỏ́c, kháu lào.</i>
Religious purposes	Glutinous	Not very soft. Black husk. Used to drive away evil spirits.	<i>Cắ́m pi, mắ́c có</i>
Medical purposes	Glutinous	Not very soft. Black husk. Can be used as medicine.	<i>Cắ́m pi</i>
Commerce	Glutinous - Regular	Very soft and fragrant. Good - looking grains.	<i>Kháu khỉnh, kháu lào, cai hỏ́c.</i>

- **Medical purposes:** Black glutinous rice is used in the treatment of health problems. It is considered a valuable medical ingredient. After the rice is steamed, it is fermented with wine enzyme or leaves and roots to make medicine.

3.2. The relationship between ethnobotanical studies and hereditary diversity within a species

3.2.1. Differences in rice categorization method between farmers and scientists

According to the categorization method

of Tay farmers, there are a total of 21 glutinous and 21 regular rice species (50:50 ratio) in Tat village (Table 4) and 21 glutinous (56.8%) and 16 regular (43.2%) rice species in Cang village. Testing with KI-I solution shows that only 17/21 of Tat village's grain samples turned red-brown (glutinous) and 20/21 turned dark blue (regular), while 18/21 of Cang village's grain samples turned red and 15/16 turned dark blue. Therefore, there are 5 samples from Tat village and 4 from Cang village that

turned both red-brown and dark blue when tested with KI-I solution. This indicates that there exists a small difference between the farmers' categorization method and that of scientists. Despite this difference, both methods show that the glutinous: regular ratio within the rice pool is close to 50:50. This reflects the wide use of glutinous rice in everyday life in the mountainous areas. This habit contributes to the maintenance of local rice polymorphism.

Table 4. Categorization by farmers and based on grain's reactions to KI-I solution.

Identification Type		Farmers' Categorization		Grain's reactions to KI-I solution	
		Number of species	Ratio (%)	Number of species	Ratio (%)
Tát Village		42	100,0	42	100,0
1	- Glutinous	21	50,0	17	40,5
2	- Regular	21	50,0	20	47,6
3	- In between	0	00,0	5	11,9
Cang Village		37	100,0	37	100,0
1	- Glutinous	21	56,8	18	48,6
2	- Regular	16	43,2	15	41,4
3	- In between	0	00,0	3	10,0

3.2.2. Farmers' evaluation and naming method for most popular rice species

An inventory of rice species in the two villages reveals that there are a number of species that have more than one name and different species that share the same name.

- Different species sharing the same name

Farmers sometime call different species by the same name. For instance, *kháu ca lan* could be either white-grained or red-grained. White-grained *ca lan* is softer and sweeter, whereas red-grained *ca lan* tastes drier and harder. Some people call the

red-grained species *ca lan đanh* and the white-grained species *ca lan hảo*, but most still call them by the same name, *kháu ca lan*. The name *kháu tấng sắn* is also shared between the glutinous *tấng sắn* and the regular *tấng sắn*; just as the name *kháu mồn* is shared between glutinous *kháu mồn* and regular *kháu mồn*. The name *kháu vắn* is shared among three different species with different husk colors: the yellow-husked species has large grains that do not fall off from the stalk easily and is often intercropped with *kháu khinh* (also called *kháu mặc*

buộm); while the other two, *kháu vắn hút* *đặm* and *kháu vắn hút* *đanh* have grains of similar quality, and are usually grown on the same plot of land. However, in most cases, different species with the same name are usually grown separately (Table 5).

- *Same species with different names*

According to results from the two different research sites, there are currently seven species in this category, each with two or three different names. These names are often derived from the grain color, fragrance, rice quality or various factors relating to the cultivation process. For example, the summer crop glutinous *mặc mau* can tolerate low-temperature and is therefore sowed widely in the winter. Hence, it is also called *kháu chiêm* (summer rice). The glutinous

kháu khỉnh (meaning fragrant ginger) is also called *lưm phũa* (forgetting the husband). This name is based on a folk tale in which a farmer's wife steams some glutinous rice for her husband, only to be so wooed by its fragrance that she eats it all before he returns from work in the fields.

Léch đặm (black and hard like iron) gets its name from the characteristics of the stalk, but is also known as *noọng nà* (the young girl in the rice field). It has white, soft and very fragrant grains.

Trặm nành is also called *trặm đanh* after the red color of the husk. *Kháu khượng*'s grains do not fall off from the stalk easily, and therefore the species is also called *kháu móc*.

Table 5. Same species with different names

Name of species	Other name	Type	Reason for different namings
Mặc mau	Kháu chiêm	Water glutinous	Mass-production summer crop
Kè dè niệu	Sa lẳng	Water glutinous	Unknown
Kháu khỉnh	Lưm phũa	Water glutinous	From a folk tale
Kháu khượng	Móc	Water glutinous	Difficult to remove grain from stalk
Léch đặm	Noọng	Water glutinous	Very soft and fragrant
Mặc buộm	Vắn	Mountain glutinous	Unknown
Trặm nành	Đanh	Mountain glutinous	Red husk

Lab studies combined with empirical ethno-botanical research shows that cultural practices are intimately linked with local rice polymorphism. The existence of rice species sharing the same name and species with more than one name may be the result of long-term intercropping, although current analysis remains insufficient to determine the exact

differences. However, it is certain that the Tay farmers' long-term selection and cultivation methods play a significant role in the polymorphism of local rice varieties.

- *Farmers' evaluation of major rice species*

The ethno-botanical study shows that the Tay learn about local plants through daily interaction, and that their deep knowledge of

these plants has been passed on from one generation to another. The analysis shows that farmers hope to conserve and further expand about 60 percent of the current rice pool and sustain about 30 percent at the minimum level in order to conserve the genes. They intend to maintain the rest either as a substitute in case of emergency or for religious purpose. The analysis further suggests that local farmers remain interested in maintaining the current set of local rice varieties for their high yields and ability to tolerate dehydration, but at the same time still hope to try growing new species, especially those popular among their counterparts in other areas.

In short, the fact that rice bears both material and spiritual value to the Tay helps explain why local farmers continue to grow a large variety of rice species on their land. This is the main factor contributing to the conservation of the genetic diversity of rice varieties in Da Bac.

3.3. The relationship between ethno-botanical knowledge and the conservation of rice polymorphism

For the Tay in Da Bac, local rice varieties not only serve as a valuable food resource but also have medical and spiritual value. Although the studies were conducted only in villages of Cang and Tat, there is sufficient evidence to confirm that the rice varieties in Da Bac are highly diverse and have been well-conserved by local farmers. Some traditional rice species may not be cultivated on a regular basis due to various reasons, but they never disappear permanently. One group of farmers may choose to grow a certain species, while another group chooses another type, and thereby enabling the two groups to exchange

their products. Studies show that rice species with short life-spans, such as *kháu mòn* and *kè đẽ*, are usually grown in between major crops to guarantee a steady supply of food during the pre-harvest seasons. *Kháu cao su*, *trăm hin*, and *trăm hé* are usually reserved for less fertile land. High-quality rice, such as *kháu tói*, *kháu khinh*, and *kháu lếch*, are saved to make steamed rice and rice pudding during special occasions. *Kháu mạc mau* can tolerate low temperatures and therefore is always chosen for the summer crop. *Kháu cãm pi* and *mạc có* are essential for medical and religious purposes. Today, *kháu khinh* and *kháu lào* are of high commercial value. This explains why the Tay in Da Bac continue to grow different rice varieties throughout generations, contributing to the conservation of the genetic diversity of local rice. The local farmers select, utilize, and conserve different rice species, as these practices are an integral part of their cultural heritage.

It is not an exaggeration to say that the enduring values of the Tay traditional culture lie in their intellectual quality. A vast amount of ethno-botanical knowledge has been transferred into simple, accessible and memorable Tay language to be used in both everyday life and agricultural production. This tradition has a long history, in which rice, as the most valuable product of human labor, has always been treasured and worshipped. It has become an inseparable part of everyday communication and has been incorporated into folk songs: *Kháu cai hóc thạm hạ kháu cai hóc/Hạ tà súc lượng thạm hạ kháu cai lượng* (Cai hóc rice asks after *cai hóc* rice/In the paddy field the yellow ripe rice asks after *cai lượng* rice); *Phụng òn chẵn động kháu chiêm*

xanh/Phụng muốn bươm cầu khâu mơn mố (Most beautiful is *mạc mau* the summer young rice/Most cheerful is the *mòn* rice in September). This indigenous knowledge dates back many generations and is transferred in the form of advice that grandparents pass on to their grandchildren, exchanges between neighbors, or courting idioms like *sli* and *hưon* used between lovers. Unfortunately, such a valuable source of folk knowledge is gradually disappearing. Scientists could play a positive role in revitalizing traditional knowledge and bringing it back to the community. This is the only way to conserve different regions' indigenous ethno-botanical knowledge and develop cultural and practical knowledge that enhances the relationship between communities and their environments. This should be considered a vital part in bio-diversity conservation work.

4. Conclusion and Recommendations

1- Indigenous knowledge, including ethno-botanical knowledge, is an invaluable cultural heritage. For the Tay in Da Bac, Hoa Binh province, such knowledge contributes greatly to the maintenance of local rice varieties as well as the diversification of rice genes.

2- There is a large collection of rice genes with a high level of hereditary diversity and ability to adapt to local geographical features in Da Bac. Such a rich rice resource not only serves as an important food source, but also plays a significant role in local medical and religious practices.

3- The farming communities evaluate and categorize local rice varieties that have been selected and planted by the local farmers

themselves. These rice varieties are of high quality, provide stable yields, have high levels of immunity against diseases, and are highly adaptable to environmental differences. The farmers' need for higher yield is the basis for further scientific studies with community participation in order to select desirable rice genes that would help improve the local rice gene pool. This would help increase rice-crop yields in a sustainable manner while also maintaining the bio-diversity and environmental health of the region's ecosystem.

4- It is essential to determine the utility value of each rice species in order to design an appropriate plan to conserve local rice genes while also developing strategies for expanding the cultivation of rice species of high commercial value, so that poverty among local farmers may be alleviated without damage to agricultural bio-diversity.

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