

Multiple Cropping System for Conservation and Sustainable Use in Jeypore Tract of Orissa, India

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Abstract

This paper examines the composition of traditional food crops among the different tribal communities and the method of sustainable food crop production. Three tribal communities, inhabiting seven villages in Orissa, India were studied. A structured questionnaire was administered to elicit information in the areas of crop mixtures and reasons for such mixtures. The study indicated that a crop mixture of millets and pulses is most popular among the farmers; the assurance of food security was the most important reason for multiple cropping, followed by staggered harvesting, which reduces the burden of work at one time. Gender roles are very clear in the cultivation practice as women have been the backbone in this type of farming. The study has, thus, provided a clear insight into the practice of multiple cropping by farmers in the study area as a strategy adopted by farmers for demand-led technology development and increase in production.

Mixed cropping in a traditional farming system is defined as the cultivation of two or more crops together on the same piece of land (Papendick *et al.*, 1976; Willey, 1979). It is a widespread practice in subsistence farming all over the tropics for varied reasons such as increased production with limited land resources, reduced risk of crop failure through staggered harvest, labor demand, diversity in diet, and enhanced utilization of resources. In several instances continuity in food supply is available over a

period of time and increased production is achieved through mixed cropping than single crop. Moreover, there is improvement in soil fertility, conservation of water and soil, and enhancement of microclimate conditions (Ranganathan, 1993; Sharma *et al.*, 1998). In the tropical regions of Latin America, 60% of maize (*Zea mays*) (Francis *et al.*, 1976), 95% of groundnut (*Arachis hypogaea*) in Nigeria, and 56% of groundnut in Uganda (Okibo and Greenland, 1976) are grown in association with other

crops. Aiyer (1949) reported that 80–90% of pigeonpea (*Cajanus cajan*; hillgram; *tur*) is intercropped in India.

Traditional farming systems are gaining attention from all over the world for their significance in maintaining biological and genetic diversity. The combination of indigenous knowledge, technology, and social organization could provide guidelines to low-income farmers to produce self-sufficient subsistent and cash crops, with minimum dependence on external inputs (Alteri and Anderson, 1986). Multiple cropping, a traditional farming system, has not only ensured continuous livelihood of farm households but also assured ecological sustainability. This small-farm system with diversified crops is more productive than improved agriculture. Women have been the backbone of this type of farming in the interior tribal areas and prefer to cultivate crops that provide food security, even though it takes more time and energy to process them. They value crop diversity and by maximizing the diversity they fulfill the nutritional needs and enhance the food security of all the family members. However, over the last few decades, this practice has been dying due to the introduction of cash crops, fruits, and high-value timber trees on uplands.

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Of late, the trend is to utilize the uplands for growing commercial crops with higher market value and lesser labor input. Acacia, cashew (*Anacardium occidentale*), sugarcane (*Saccharum officinarum*), groundnut, maize, etc. are grown in the uplands and tribal people buy/barter their traditional food grains from the profit (Sharma *et al.*, 1998). Growing of uniform commercial crops invites high risk of failure at times, as there are only limited varieties of commercial crops for which the price and market are stable in tribal areas. Mixed farming is an alternative way to meet the challenges of the rising population, land use pressures, and conservation of subsistence crops for sustainable agriculture. Prof. MS Swaminathan (1996) had said in the Madras Declaration that “there is a need to move away from a ‘favourable area’ and ‘favourable crops’ mindset, and to enlarge the contents of the food basket by including the excluded in terms of under-utilized plants and neglected ecosystems. If implemented, this will be of immense value to the tribals in times of acute food shortage. The existing food gathering and food production system needs careful attention, particularly during the phase when tribal agriculture is in

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transition, because some alterations in the system can result into serious consequences for life and living.”

This study is an attempt to analyze the sustainable use of multiple cropping patterns among tribal farm families. The paper specifically investigates common crop combinations and the reasons for using them in multiple cropping patterns, as well as the role of women in conserving and utilizing traditional knowledge at various stages of mixed farming.

Study area

Jeypore tract (undivided Koraput district) is the southernmost district of Orissa, India, famous for its overabundance of biodiversity, coupled with a mixture of tribal cultures and poverty and its varied geographical and ecological attributes (Fig. 1). It is essentially an upland plateau region with spurs of the Eastern Ghats cutting it. The tribal population constitutes 53.74% of the total population. These people are inhabitants of the hills and forests since time immemorial. Nearly 89% of the population live in villages. They live with their simple tradition bound socio-cultural nexus (Mohanti *et al.*, 2005).

Agriculture is the mainstay of the economy and engages most of the working people. The various tribal groups practice shifting

cultivation and settled agriculture in rainfed conditions. Rice (*Oryza sativa*) is the main crop, followed by millets, pulses, oilseeds, fiber crops, and vegetables. Mixed cropping in the uplands, locally known as *misha chasa*, is widespread throughout the district and across different tribes. To maintain sustenance for the growing population with the limited land available and to conserve the crop diversity and associated traditional knowledge, farmers opt for mixed farming in the uplands. However, the improved cultivation practices of the Green Revolution and high-yielding varieties (HYVs) of different crops are mostly suitable for lowland agriculture. Tribal farm families could not fully adopt the improved cultivation practices and HYVs because of their traditional farming system, food habits, and poor economic condition (Tripathy *et al.*, 2005).

Tribal farm families

Tribal farm families in Jeypore tract exhibit a backward socioeconomic attitude and practice different economic pursuits to eke out their living (Patnaik, 2005). The primary occupation of the people is agriculture. Subsistence farming still remains their main source of livelihood, supplemented by forest collection and earning wages. The agricultural produce is insufficient for providing sustenance throughout the year, as 70% of them are small and marginal farmers with an average landholding of 1.88 ha and operational holding of 0.59 ha (Directorate of Economics and Statistics, 2005). Mixed cropping is a predominant agricultural system in the uplands, in addition to monocropping in all the three land

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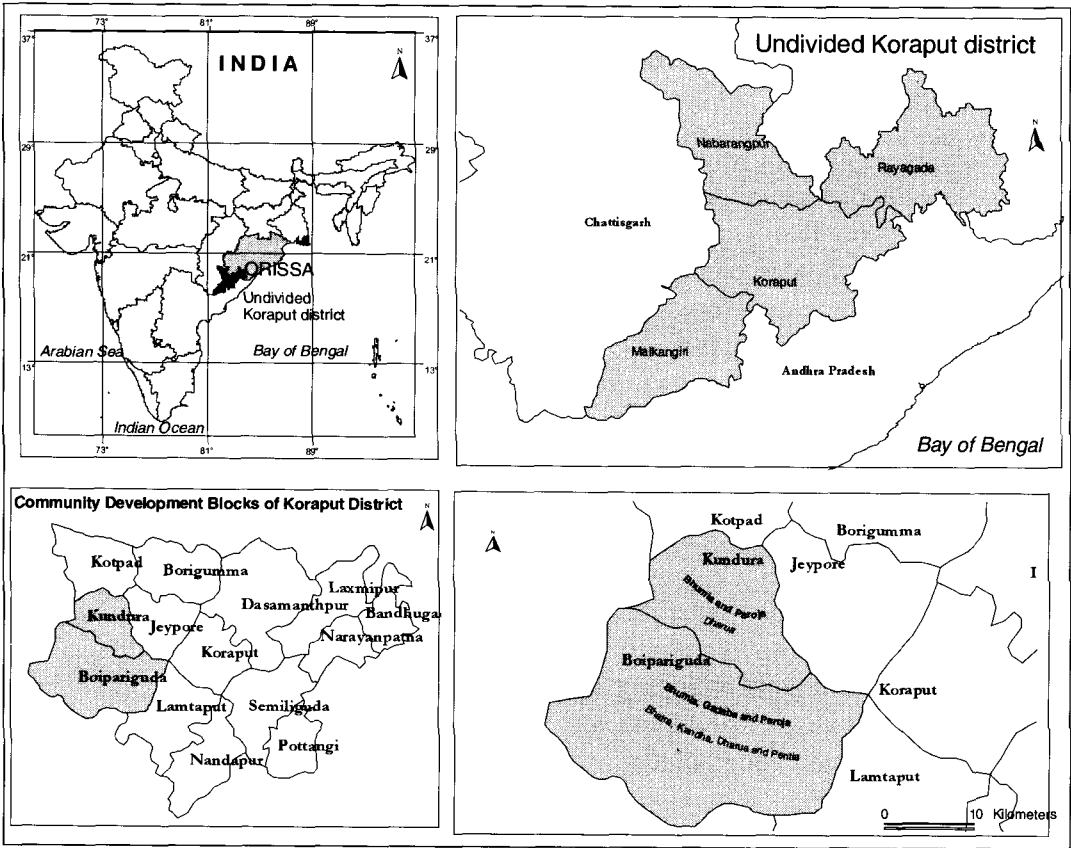


Figure 1. Map of Jeypore tract of Orissa in India showing distribution of different tribes.

categories, viz., upland, medium land, and lowland. Among the several tribal communities, primitive tribes such as the Bondos, Gadabas, and Souras cultivate mixed crops extensively on the hill slopes whereas the Koyas, Parojas, and Bhumias cultivate mixed crops in the plains, but less extensively. Cereals, pulses, millets, oilseeds, and fiber crops are mixed in different proportions according to the family needs.

Methodology

Seven tribal-dominated villages were studied under four Panchayats and two Community

Development Blocks. The three major tribal groups dominant in the surveyed villages were Bhunia, Paroja, and Gadaba. Focused group discussion was arranged and data collected from farm families currently practicing mixed farming. Detailed documentation of the crops, cropping patterns, storage, and food processing was done. Field visits were made to understand their indigenous technical knowledge in raising multiple crops in different combinations. Photographs of the fields and storage structures were taken. A special discussion was held with the women to chronicle their knowledge on the utilization of various crops throughout the year.

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Observations and discussion

From the study it was observed that tribal farm families residing in interior areas practice mixed cropping primarily for their subsistence. They grow various crops and the production is just sufficient to fulfill the family's wide-ranging food needs. Only a small surplus, if any, is marketed locally. Family members carry out traditional methods of cultivation, as the landholdings are small and scattered. The various crops harvested are consumed in different periods of the year.

Land utilization pattern

There is more upland in the villages compared to medium land and lowland. Of the cultivable lands, upland occupies 66%, medium land 22.5%, and lowland 11.5%. Short-duration paddy covers only 16.74% of the total upland; therefore, upland farmers cannot produce sufficient grains to meet the family needs. Fragmented lands in rainfed

systems and low soil fertility are believed to be the reasons for low productivity.

In the surveyed villages, rough estimates suggest that 60 to 80% of farm families practice mixed cropping. The average area cultivated under mixed cropping per household varies from 0.25 to 3 acres (0.1 to 1.2 ha). The crop mixtures differ considerably from village to village depending on the cultural background of the various tribes, agro-ecological conditions of the land, and existing crop resources.

Diversity of traditional crops

The tribal farm families cultivate a few specific crops that have varying periods of maturity, which suit their farming and socioeconomic environment. These crops are usually millets (rich in minerals and vitamins), pulses (rich in proteins, especially some amino acids), and oilseeds. Millets, particularly finger millet (*Eleusine coracana*; *ragi*), are known as life-saving crops because they provide food to the family during times of acute shortage (Das, 2006). About 2 to 8 crops are mixed in different proportions and grown together. The earliest variety of finger millet is generally harvested in September and is the first crop in the new food cycle of the year. This gradually builds up with a larger quantity and different species of plants, such as early variety of

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rice, followed by medium-duration *suan* (*Panicum miliaceum*) and ends with long-duration blackgram (*Vigna mungo*; urd), *til* (*Sesamum indicum*; sesame), *kala til* (*Guizotia abyssinica*; niger-seed), pop sorghum (*Sorghum vulgare*), and pigeonpea.

Crop selection

Crop selection is an ancient practice based on empirical knowledge accumulated through centuries. Tribal farmers select various crops on the basis of their duration, morphology, and food needs of the family. They preferably select crops of unlike plant heights and maturity duration so that each crop can utilize sunlight completely. Tall plants like *suan* and pop sorghum do not compete with the small plants for food as roots of these plants penetrate deep into the soil and absorb their food from inner layers. Millets are hardy, drought tolerant and include both short- and long-duration crops, which have a direct bearing on the family food needs (Das, 2006). The short-duration crops such as early maturing finger millet, followed by rice fulfill the immediate food needs of the family and support the most difficult food scarcity periods in the annual food cycle, especially for the primitive tribal groups inhabiting the interior pockets. *Suan* and pop sorghum are stored for special

occasions like marriages or social functions. Pulses like blackgram and pigeonpea are included as they are consumed at home even before maturity. The pods of pigeonpea and blackgram are plucked when unripe and are used as green vegetables to make curry. The pods are boiled and consumed during food shortage. After harvesting, pulses are consumed as a supplementary food item. Pulses have a good market price and also add to the economy. Finger millet plants give support to blackgram as the latter is a creeper and their combined yield is more than the sole crop yield. Disease and insect damage is less and likely to be more evenly distributed as each crop has a different tolerance level. The *kala til* plants on the field border prevent the entry of livestock and minimize insect and pest attack. The increase in total output is probably the most important reason why farmers prefer mixed cropping (Ranganathan, 1993; Das, 2006). It is perhaps a more effective way to reduce risks. From the crop combination it can be seen that rice and finger millet dominate the seed mixtures, as these two are the staple food of the tribal people.

Crop combinations

Crop combinations vary considerably depending on the local demand, menace from wild animals, and cultural practices. Rice or finger millet is used as the major crop and other crops are mixed in smaller proportions according to the family need. The proportion of seed of finger millet and other crops is 2:1; in case of rice, the seed proportion is 9:1. Presently, farm families particularly women do not prefer rice as the

major crop of mixed farming as they face difficulty in harvesting. Compared to rice, finger millet occupies a prime position and is used as the main crop in majority of the mixed cropping fields. In our study villages, nearly 80% of the farm families selected finger millet as the principal crop in mixed cropping practices. Only 20% of the farm families opt for rice mixtures.

Crop rotation

Crop rotation is a regularized practice among the tribes for various benefits such as maintenance of soil fertility, high yields, and avoidance of diseases and insect and pest attack. Rice and finger millet, the two prime crops in multiple farming, are grown alternately in the same piece of land. By this practice tribal farmers keep their fields under continuous production instead of leaving them fallow. Crop rotation is also beneficial for weed control. For example, finger millet fields have less weeds compared to rice fields. Big and healthy panicles of finger millet are produced with crop rotation.

Cultural values

Some traditional crops have high cultural value in tribal areas. These crops play an important role in maintaining customs and traditions and are part of the cultural heritage. Tribal women use traditional crops on special occasions as they have knowledge about the processing, preservation, and cooking. Among the various crops used in the mixtures, *suan* and pop sorghum are very important in religious festivals and marriage

ceremonies. *Suan* is used to make sweet dishes on religious days. Pop sorghum is popped and exclusively used in marriages (Table 1). Respondents reported that they store the harvests for their own consumption as well as for selling locally.

Farming system and tribal wisdom

Mixed farming is a reflection of tribal informal experimental wisdom. Many indigenous varieties of cereals, millets, pulses, and oilseeds are being conserved and utilized for household food security. Within each crop there are varieties with different maturity dates and morphological and agronomic characteristics. Seeds of different crops are sown together in various proportions and broadcast at a time or one after the other, depending on the characteristics of the crops. Harvesting starts in September with the early maturing finger millet and ends in January with pigeonpea. During this period, other crops mature at different intervals providing continuous supply of foods.

Finger millet is the life-saving crop in tribal areas as it synchronizes well with the food demand of the family as well as land and moisture availability. Unbounded uplands are utilized to grow finger millet where the moisture content is very low. In this way tribal farmers are able to utilize their experience and knowledge to optimize the immediate family food requirements as well as reserve for the future. A majority of the farm families grow 2 to 5 crops for their everyday food. They select at least one each of millet, pulse, and oilseed crops. Short-

Table 1. Mode of preparation and consumption of different products and present market value.

Crop	Month of harvesting	Cooked products (grain and pods)	Use of other parts	Market value ¹ (Indian Rs per kg)
Rice	September/ October	Rice, <i>pendum</i> (alcohol), pressed rice, <i>nuakhia</i> cake	Fodder and thatching, rope making from harvested crop, firewood	3.50–4.00
Finger millet	August/ September	Gruel, <i>landa</i> (alcohol)	Firewood in winter	6.50
<i>Suan</i>	November	<i>Payasam</i> , <i>halwa</i> , and <i>uppuma</i>	Fodder, firewood in winter	12
<i>Kala til</i>	December	Edible and body oil	Fuel, medicines to cure cold, husk is spread in poultry shed for laying eggs	10–12
Pigeonpea	January/ February	Dhal, boiled pods, curry	Fodder, making fence, firewood in winter, compost	50
Blackgram	November/ January	Dhal, boiled pods, curry	Firewood in winter, fodder, compost	50
Pop sorghum	December	Popped sorghum (for marriages throughout the year)	Firewood in winter	10
Sesame	December	Edible and body oil	Compost, firewood in winter	18

1. 1 US\$ = 40 Indian Rupees approximately.

duration rice is used to celebrate *Nuakhia* or *Bali jatra* as a part of tribal culture and to fulfill the household food requirement. Coarse rice with red kernel is used for pressed rice (flaked rice), as that is highly preferred by the people. If the harvest is abundant, farmers give rice as wages to medium and lowland agricultural laborers. The straw is used to make ropes, which are used to tie harvested rice bundles in the field.

Blackgram is grown with finger millet as this combination yields more and incidence of diseases is less compared to monocropping. When blackgram is grown alone, its leaves turn yellow and branches get intertwined, making harvesting more difficult. Net economic profit is more as pulses have a higher market value (Table 1) and the family gets diversified food over a period of time. *Suan* grows very fast and has a very strong

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root system, which enables the plants to withstand heavy rains. It is mixed with finger millet in a proportion of 1:25. This combination promotes production of healthy and big panicles of *suan*. The yield is more for both the crops when grown together. Scattered *suan* plants ward off the birds that are attracted to the young panicles. In the tribal culture, finger millet gruel is a staple food in the daily diet. *Suan* is cooked as a special dish for social functions and celebrations. The tribal people store *suan* for a year to be used by them or to be sold to neighbors, as it fetches double the price of finger millet. Pigeonpea and blackgram are long-duration crops and are considered support crops in case millet or other cereal crops fail. Pigeonpea has adapted well to the area and physical conditions. The seeds are consumed and rest of the plant is used as fuel as the plant grows up to six feet. The pod cover is also used as feed for animals. *Kala til* is an important oilseed crop and is grown extensively by tribal farmers. It performs well under poor soil conditions, is resistant to drought and repels birds, animals, and insects from the other crops (Das, 2006).

In mixed farming, the seeds of pigeonpea are broadcast first, followed by plowing. Farmers follow this practice to protect the

seeds from birds, as the seeds are prominent due to their large size and also to allow the seed to go deep into the soil so that the plant is well established as it is approximately 6 to 8 feet height at maturity. In finger millet and blackgram system, seeds of both the crops are mixed and sown. After broadcasting, farmers level the land to ensure more germination and uniform crop growth. In rice-based system, they broadcast rice and pigeonpea seeds together followed by plowing. Then blackgram and *suan* seeds are broadcast and the field is leveled to maximize germination percentage.

Storage techniques

Special traditional techniques are strictly followed for safe storage of the traditional food crops (Fig. 2). Rice and millets are stored in earthen pots, bamboo baskets, and gunny bags covered with straw and plastered with cow dung to make the baskets airtight. Pulses like pigeonpea and blackgram are mixed with red soil, dried, and then stored in bamboo baskets plastered with red soil and covered with straw and cow dung. Panicles of pop sorghum are normally hung from the roof near the fireplace to keep them free from moisture and insects. Small quantities of *kala til* and sesame seeds are stored in small bamboo baskets and earthen pots and covered with straw and cow dung for safe storage.

Loss of traditional crops and dying cultures

Over the years, due to erratic rainfall and late monsoon pattern (climate change), the



Figure 2. Food grains stored in earthen pot and bamboo baskets.

culture of mixed farming is slowly disappearing from the tribal areas. It is affecting the area under cultivation, farm families, and number of crops used. With the onset of monsoon, tribal farmers are engaged with medium and lowland farming, which fulfill their economic need in addition to consumption need. Due to changed monsoon pattern, the yield is decreasing over the years. Since millets mature early, they are more prone to wild animals like bear and boar as well as birds. Pop sorghum and finger millet are spoiled by wild boars if the village is near the forest. *Suan* is eaten by birds if found in large quantity. Pigeonpea attracts more insects from the rice field after

harvest and the plants struggle for their survival in very dry conditions. Sesame is usually excluded, as the farmers remain busy during the harvesting time and little delay in harvesting allows opening of the pods resulting in yield loss. Due to late monsoon, harvesting rice gets delayed, as rice plants grow taller. While harvesting, women face difficulties as their hands get cut with *suan* leaves. Growing rice as a major crop in mixed farming is slowly vanishing. Due to access to markets, tribals have started buying edible and body oil from outside the village. Despite this, they retain their culture through this small farming system.

Gender roles

Unlike other cropping systems, mixed cropping in uplands is the prime responsibility of tribal women, especially when landholdings are small. Though men possess knowledge of this native cropping system, it is women who carry out all the practices in the field, except land preparation (Fig. 3). They have successfully carried this traditional agricultural practice from generation to generation despite their heavy workload at home. Through specialized knowledge, skills, and experience, they make the choice of different crops and the proportions, based on the food need of the family and ecological condition of the field. Women help in field preparation by clearing

bushes, selecting the crops and preparing the seed mixtures before sowing, carrying manure to the field, weeding, harvesting, threshing, and storing. Women carry out the first hand weeding operation after plowing and before seed sowing and this plays a key role in crop production. They spend about three to four days for weeding to enhance the crop productivity. Second weeding is carried out based on the moisture level of the field. If the field is dry, they do not weed. They have specialized knowledge of seed selection and storage techniques, which involve time and labor. Seeds are normally stored from the previous year's harvest. In case of scarcity, they prefer to buy from the weekly market by paying cash or through the barter system. Seed loan is



Figure 3. Weeding activities in a mixed farm of rice, pigeonpea, pop sorghum, and *kala til* by tribal women in Orissa, India.

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comparatively more expensive as they have to repay 100% more seeds on the loan quantity. Seed selection is done by women before sowing and after harvesting by winnowing in a hand winnower and discarding under-developed grains, sticks, or mixtures of other crops. Men prepare the field with a hand plow and decide the quantity of seeds required for sowing. Early in the morning they carry the seeds to the field. They broadcast the seeds together or one after the other. Harvesting is done by women with the help of young girls. In most cases, transporting of crops is done by men. Threshing is decided by looking at the crop and quantity and usually done by male members using bullocks. Women help in preparing and cleaning the threshing yard. The crops which need more energy are threshed by both men and women; e.g., finger millet, blackgram, sesame, and *kala til*. Women take care of winnowing, cleaning, and storage of seeds. Depodding of pigeonpea is done by women followed by cleaning, seed selection, and storage. *Suan* and pop sorghum are threshed manually and women take the responsibility of seed selection and storage. Food processing is the sole responsibility of

women. They spend two to three hours daily on this activity: sun drying the grains, manual pounding in case of rice and *suan*, winnowing and cleaning, followed by food preparation. In the case of finger millet, grinding the grain in stone grinders to make a powder for preparing gruel is an indispensable task for them and is a part of their routine.

Conclusions

Multiple cropping in Jeypore tract has been dependent exclusively on traditional knowledge and skills. When compared to HYVs and modern agricultural practices, productivity in traditional multiple cropping is low and scientific skills are lacking. However, it is evident that this traditional agriculture has been stable over a long period of time. Since women take care of the whole practice, food security at household level is given utmost priority with diversified foods. Traditional skills of crop and land management and various storage techniques have been rolled down from generation to generation. It is important to create awareness among farmers to improve their traditional skills and wisdom with modern scientific knowledge, which would enhance local livelihoods, together with conservation of natural resources. The nutritional value of traditional crops needs to be analyzed and recognized as these crops are significant components of the tribal diet.

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