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Economics of Foxnut (*Euryale ferox* Salisb.) cultivation: A case study from Manipur in North eastern India

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The Foxnut or Gorgon nut (*Euryale ferox* Salisb.) belonging to the family Euryalaceae and locally called as "Thangjing" in Manipuri and "Makhana" in Hindi is an important annual aquatic vegetable cash crop of Manipur. Both leaf petiole and fruits after removing the spiny cover are eaten raw or cooked and is regarded as a delicacy in the traditional cuisine and is highly preferred. The foxnut fruits are sold in the local markets of Manipur during June-October with an estimated quantity of 43.4 tonnes which fetch around Rs 3.8 lakhs annually in Imphal market alone. The agro-practice and estimation of economics of foxnut has been carried out. Around 2500 plants with plant to plant spacing of 2×2 m^2 can be cultivated in one hectare of land with an annual production of 75,000 fruits which is on an average yield of 30 fruits per plant annually. The market cost of foxnut fruit varies from Rs 2-8 per fruit depending upon the size of the fruit, availability and season. Under scientific cultivation of foxnut, a total income of Rs 2.25 lakhs can be generated annually per hectare of land where Rs 2.09 lakhs is the net income.

Keywords: Foxnut, Gorgon nut, *Euryale ferox* Salisb., Thangjing, Makhana, Agro-practice, Economics, Manipur

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Introduction

Manipur, one of the eight states of North eastern India falls within Indo-Burma centre of biodiversity hotspot of global significance. The state lies between 23°27' to 25°41'N and between 93°61' to 94° 48'E with a total geographical area of 22,327 km^2 and mainly comprises of hilly terrains surrounding a saucer-shaped centrally located valley called as Manipur/Imphal valley (1856 km^2). There are altogether 27 ethnic people in the state. The state can be described as 'paradise for wild edible plants[1]. The wild plants have exercised the culinary imaginations of the people in Manipur since yore[2]. The state is having a vast area of wetlands/water bodies supporting huge aquatic biodiversity. The local ethnic people include lots of green leafy vegetables particularly wild herbs in their daily diet and the traditional cooking which still prevails that requires very less fat/oil. The aquatic plants play a significant role in their daily diet and also for treatment of various diseases and are often sold in the local markets thereby earning livelihood for a large section of rural populace. Economically poor families depend largely upon the wild plants from the surrounding wetlands not only for food but also for other requirements. A large share of dietary nutritional requirements is supplemented from the wetland/aquatic plants. Among the nutritional edible plants grown in the wetlands/water bodies, Foxnut or Gorgon nut (*Euryale ferox* Salisb.) is a very important species. The objective of the present study is to develop agro-technology and estimation of economics for its cultivation.

The 'Foxnut' or 'Gorgon nut' belonging to the family Euryalaceae, is a spiny aquatic plant with circular floating leaves and tough fibrous roots. It is mainly distributed in East Asia to China to North and North East India. Popularly known as 'Makhana' in Hindi and 'Thangjing' in Manipuri has widely been used in traditional oriental medicine to cure a variety of diseases including kidney problems, chronic diarrhoea, excessive leucorrhea and hypofunction of the spleen. Based on the recent studies revealing its antioxidant activities and its glucosides composition, it is found that *E. ferox* seeds

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(Makhana) could reduce myocardial ischemic reperfusion injury[3]. In China, it is esteemed as cooling tonic food. The seed is sweet and act as analgesic and aphrodisiac. It is also taken in the treatment of acute diarrhoea, vaginal discharge and frequent urination in local traditional system. In North Bihar region, makhana is an essential component of the religious culture. No ritualistic ceremony like marriage, sacred thread or shradha (last rites) could be performed without it[4]. makhana starch is applied to cloths to provide a glaze. Bihar accounts for over 85% of the makhana production of the country which resulted into thrust area for taking up the task and identifying the constraints in the export of makhana from the state. As per a report nearly 50,000 tonnes of makhana worth nearly Rs. 550 crores in market are produced annually in India[4]. In Manipur, foxnut has traditionally been cultivated as cash crop since long time back in private ponds mainly in the four valley districts namely, Imphal West, Imphal East, Thoubal and Bishnupur. The fruits and leaf petioles are edible and regarded as delicacy and sold in local markets thereby earning livelihood for a section of local populace. The fruits are used in diabetes and fresh leaf petiole paste applied on burns and boils[5]. However, there is a need for undertaking an extensive research for its economical cultivation, harvesting and processing for large scale commercialization.

Materials and Methods

The market availability and quantification of Foxnut was surveyed at Imphal vegetable market (state capital of Manipur) and data were collected and pooled based on the number of vendors and quantity sold in a temporal cycle. Visits were made regularly to Imphal market and collected the data on alternate days. The authenticity of the species (Foxnut) was confirmed through scientific literature[5]. Interviews were taken with the vendors which were women dominated to gather the information on source, quantity sold, seasonal availability and pricing of the Foxnut sold. The data were cross-checked among the vendors for getting more accurate data. Agro-technological field experiments were conducted at Karam village of Imphal West of Manipur state in a plot/pond size of 24×54 sq. m. during 2006-08. Three replicates were taken in the designated area and field data were collected/recorded. The yield (fruits) of the plants was estimated after harvesting of the mature fruits and average figure was taken. The data on various uses of foxnut were collected through primary and secondary sources. Some of the resource persons (21) from different localities like, Ningombam, Karam, Haoreibi, Bishenpur, Mayang Imphal, Wangoi and Moirang) were interacted and collected the data on traditional uses, cultivation, harvesting and market prospects. Observations were made in the private cultivation farms.

Results and Discussion

The foxnut is one of the most promising income generators for the local populace of Manipur and is regarded as a delicacy and highly preferred annual cash crop. A total quantity of 43.4 tons of foxnut fruits was sold during 2006-07 in Imphal vegetable market alone which fetched around Rs. 3.8 lakhs[6]. Both fruits/seeds and leaf petiole after removing the spiny cover is highly edible by the local people (as traditional salad called 'Singju') but generally it is not sold in the local markets (Plate 1a). In other states of India, the seeds are generally not eaten raw but they are popped in North Bihar to make makhana which is highly priced and exported outside the country after processing. In the local markets of Manipur, foxnut fruits (Plate 1b) are generally sold @ Rs. 2-8 per fruit depending upon the size, season and availability. The ripe seed aril (Plate 1c) is regarded as a delicacy in Manipuri cuisine. It is generally mixed in raw form with a traditional dish called 'Eronba'. The young seeds are generally cooked with other vegetables while the matured seeds are used in raw form for the preparation of 'Eronba' and 'Morokmetpa' dishes. In both 'Eronba' (soup based) and 'Morokmetpa' (soupless), fermented fish locally called as 'Ngari' and chilli is required.

The people of Manipur have rich traditional knowledge on cultivation, harvesting and uses of foxnut. Based on the traditional knowledge information and field experimentation, cultivation technique of foxnut is developed (Table 1). The pictorial flow chart of the agro-practice (crop-cycle) of foxnut is presented in Plate 2. The best time for sowing the seeds is late spring (March end part). The seeds sprout after 10 days of water soaking, ash treatment and temperature control. The sprouting success of 75-85% was obtained. The sprouted seeds can be cultivated directly to the prepared beds having 5-7cm water depth. The most suitable spacing between the plants for cultivation is 2m×2m and a total number of 2500 seedlings can be cultivated in one hectare of land. The production of fruits and its maturity takes 80-90 days after cultivation. On an

Plate 1—a. Cut pieces of leaf petiole after removing spiny layer; b. Spiny fruits; c. Seeds with aril and without aril

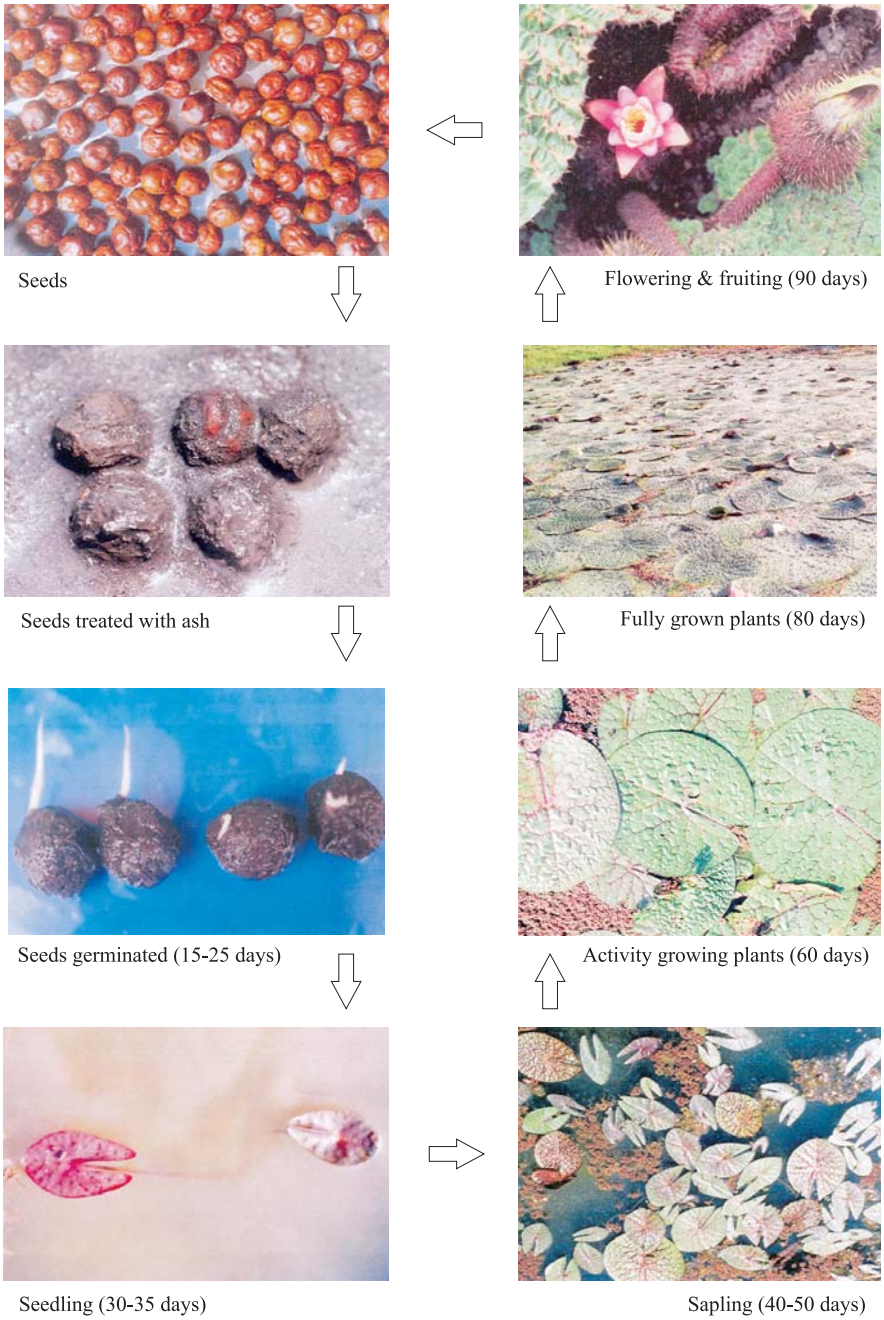

Plate 2—Agro-practice (crop-cycle) of foxnut plant

Table 1—Agro-practice of foxnut (*Euryale ferox* Salisb.)

Parameters	Details
Agro-climate	Tropical and temperate climatic conditions having higher rainfall and good sunshine.
Soil condition	Clay and silt types of soils and *p*H of the soil between 5.5 to 6.5 with good sunshine and humidity. Ponds having good and permanent water source is very suitable place for its cultivation. Loam soil is also suitable.
Propagation	Through seeds
Economic life	Annual (profitable harvesting of fruits can be started from June onwards till October).
Agro-Practice	Seeds are best sown as soon as they ripe as the seeds have short viability and must not be allowed to dry. The seeds can be stored at room temperature but should not be allowed drying completely. Certain moisture should be maintained. The best time for sowing the seeds is late spring (March end). First, the fresh mature ripe seeds will be soaked in water for 2-3 days and then mixed with some ash and organic manure and wrapped it with a piece of gunny bag and kept it for 8-10 days in shady places. Sprinkle some water for every day. Then the seeds are sown in the ponds/prepared beds at a spacing of 2.0×2.0 m. At the time of sowing the seeds, the level of water will be maintained at 3-5cm depth. Within 8-12 days, the seeds sprout and after a week or so small leaves start arising. First the cotyledonary leaves are sagittate and then cordate in shape and reddish/brown in colour. At this stage the level of water can be raised up to 10 cm, 15 cm, 20 cm and so on as per the response of the growth of the plant. The fully grown plant will be of dark in colour with green leaves having purple veins and are circular in shape with lot of sharp spines both on stems and leaves are present. When the shape of the leaf is almost circular the level of the water of the pond can be maintained at 90-120 cm depth. After 2 to 3 months of sowing, the plant will be matured and starts producing flowers. In the early part of June, the plants produce fruits which can be harvested once it is matured. The spines present in the fruits are indicative of the maturity of fruits. If the spines are sharply pointed, the fruit is regarded as young/immature whereas the spines are slightly blunted; the fruits are still matured. If the fruits are over matured, the fruits will burst and seeds will be floating over the surface of water which is difficult to collect. The harvesting season extends from June to October. Harvesting can be done for every 5-6 days. The crop-cycle is presented in Plate 2.
Time of sowing	March (mid-end)
Yield	On an average a plant may yield 30 fruits a year.
Germination percentage	75-85%
No. of plant/ha	2500 plants can be cultivated per hectare of land/pond with a spacing of 2.0×2.0 sq. m.
Gross annual income/ha	Rs 2,25,000/-
Total cost on labour (8 labours for 5 days for sowing and 1 labour for 60 days for caring and harvesting @ Rs. 150 per day), seeds (Rs. 450), gunny bag (5 bags @ Rs 20)	Rs 15,550/-
Net annual income per hectare	Rs 2,09,450/-

Table 2—Techno-Economics of *Euryale ferox* cultivation

Income		
	Line to line and row to row spacing between the plants	2.0 m × 2.0 m (4.0 m^2)
	Number of plants cultivated in one hectare of land	2500 plants
	Yield/ plant/year	30 fruits
	Productivity/ha/year	75,000 fruits
	Annual income from one hectare of ponds/land	Rs 2,25,000
Expenditure		
	Manpower requirement for one hectare of land or pond	8 labours for 5 days @ Rs 150/day$^-$ = Rs 6000
	Manpower for caring	1 labour for 2 months @ Rs 150/day = Rs 9000
	Cost of seed purchasing for plantation of one hectare of land	Rs 450/-
	Empty gunny bag (5Pc @ Rs 20)	Rs 100
	Annual expenditure in one hectare of ponds/land	Rs 15,550
Net Income	Net income from one hectare of land/annum	Rs 2,09,450

* (Pond preparation is only one time investment and does not reflect in this calculation)

average, a plant can yield 30 fruits annually which accounts to 75,000 fruits in one hectare of land annually. Based on the above yield figure and by considering at the average cost of Rs 3 per fruit, an income of Rs 2.25 lakhs can be generated annually from one hectare of land where Rs 2.09 is the net profit (Table1). The detail of the economics of foxnut cultivation is presented in Table 2. During the peak production season, the cost of foxnut in the local markets of Manipur declines considerably and during the period, the seeds can be popped as makhana for which popping technology may be learnt and procured from other places like North Bihar. The comparative income between traditional selling in the local markets of Manipur and after popping can be further studied. The details of agronomy, production and processing of makhana in other parts of India are avialble[7].

Conclusion

Along with the cultivation of foxnut plant, rearing of fishes like air-breathing and bottom-feeding can be cultured which can earn additional income. The fishes suitable for rearing along with foxnut plant are Ukabi (*Anabas testudineus*), Porom (*Chana* sp.), Ngamu (*Chana* sp.), Ngakra (*Clarias batrachus*) and others. Culture of other fishes like surface and mid-feeders are not suitable due to the anoxic condition caused by firmly spreading leaf lamina on the water surface and the long and sharp spines present throughout the plant body of foxnut.

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