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Role of aquatic plant in the livelihood purposes in the wetlands of north Bihar

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Abstract
It is well known fact that wetlands are highly productive region and may be considered as kidney of nature thus it must be protected and managed. Keeping these in view present investigations were carried out with the main objective to role of aquatic phytodiversity in the development of north Bihar through various ecological aspects and emphasis on their utilization. During the study period it has been found that wetlands of Darbhanga support a bewildering array of flora and fauna and contain relict of plant species from the tertiary period, which are of great limnological interest. These include *Euryale ferox, Vetiveria zizanioides, Scirpus articulatus, Typha australis, Alternanthera sessilis, Asteracantha longifolia, Trapa bispinosa, Nelumbo nucifera, Nymphaea alba, Eichhornia crassipes, Ipomoea aquatica, etc.* Development strategy of a region could succeed only, if it incorporates the optimum harnessing of the indigenous resources available in the area. It is with this purpose that the wetland plants growing in the floodplains of north Bihar need to be harnessed in a better way for meeting the livelihood purposes of food (including fodder for animals) and other allied needs.
The indigenous practices of utilizing a no. of these plants for curing human and bovine ailments have been proved experimentally and as such there is a need to incorporate them in the primary health care system, more particularly for control of deficiency diseases on the one hand and their use as source of anti-obesity and anti-diabetic drugs on the other.

Keywords: North Bihar, aquatic plant, livelihood

Introduction
Floodplains are important in the sense that all the major world civilizations have emerged and developed alongside them. Geological changes have helped create different types of water bodies and the aquatic ecosystem is of vital concern to humans and other living beings. Floodplain wetlands help the recharge of ground water, recycling of nutrients and purification of polluted water. They provide habitat for a variety of aquatic flora and fauna and a basis for various sorts of aqua-culture including pisciculture, deepwater rice cultivation, *Makhana* and *Singhara* cultivation etc.
Despite these benefits wetlands are the first target of human interference and are among the most threatened of all natural resources. Around 50 % of the earth's wetland is estimated to have already disappeared worldwide over the last hundred years through conversion to industrial, agricultural and residential development. Even in current scenario, when the ecosystem services provided by wetlands are better understood–degradation and conservation of wetland continues. This is largely due to the fact that the "full value" of ecosystem functions is often ignored in policy making, plans and corporate evaluation of developmental projects.
Wetlands support a large variety of plant and animal species adapted to fluctuating water levels. Wetlands are one of the most productive ecosystems as compared to the terrestrial ones and play a crucial role in hydrological cycle. In view of utility, wetlands directly and indirectly support millions of people in providing services such as control of flood and water pollution, as food, fiber, raw materials for wood, medicine, ornamental purposes, scenic beauty, educational are recreational benefit. Wetlands exhibit enormous diversity according to their geomorphological location, water regime, chemistry as well as habitats of flora and fauna.

Material and method
A survey was made of the major floodplain wetlands in and around Darbhanga district including chaurs, moins (ox bow lakes) as well as other natural and manmade water bodies.

Round the year observation were made on the aquatic and semi-aquatic aquaphytes found in the wetland areas of Darbhanga district and plants of ethnobotanical importance were identified for documentation of their diverse usages. Herbarium specimens were prepared as per standard procedure and proper identification was made through consultation of taxonomic literature on this group of plants. Information was collected with reference to variations in their past and present utilization patterns.

Result and discussion

Keeping in view the significance of aquatic plant on the Mithila regional economy, *Euryale ferox (Makhana)* is a major basis of livelihood for the fishing community (Mallah) in this district. *Makhana* is generally consumed in pop form mostly as snacks and as 'Payas' It is also cooked as vegetable and pulse as mixed preparations. One cannot think of '*Kojagara'* festival (solemnized on the occasion of *Ashwin Poornima*) without *Makhana*. It is customary for a bride's parents to send a gift of *Makhana* to the groom's kin in the first year of their marriage. *Makhana* forming a component for "Prasad" at a pilgrimage site. *Makhana* pops forming a significant component of a marital ritual in Mithila. A non-flower garland made of Paan (Betel) and Makhana – both considered highly auspicious in this region. Garlands made of *Makhana* pops are offered to deities and distinguished guests to add elegance to the event (Jha and Goel, 2004).

Table 1: Local, botanical names and family of the aquatic plants under ethnic use in north Bihar.

Local Name	Botanical Name	Family
Bhent	*Nymphaea alba* Linn.	Nymphaeaceae
Jalkumbhi, Kechuli, Pupuch	*Eichhornia crassipes* Solms.	Pontedariaceae
Kamal (Purain)	*Nelumbo nucifera* Gaertn.	Nelumbonaceae/Nymphaeaceae
Karmisaag	*Ipomoea aquatica* Forsk.	Convolvulaceae
Kataraghas	*Vetiveria zizanioides* (Linn.) Nash.	Poaceae
Khubahi	*Scirpus articulatus* Linn.	Cyperaceae
Makhana	*Euryale ferox* Salisb.	Euryalaceae/ Nymphaeaceae
Pater	*Typha australis* Schum and Thonn.	Typhaceae
Sarahanchi	*Alternanthera philoxeroides* Griseb.	Amaranthaceae
Sarahanchi	*Alternantheria sessilis* DC.	Amaranthaceae
Singhara	*Trapa bispinosa* Roxb.	Trapaceae
Tal makhana (Gokhura)	*Asteracantha longifolia* Nees.	Acanthaceae

Makhana seed with moderate 10 – 12 % protein content is known for high essential amino acid index (EAAI) of about 90%. This makes it comparable to fish and mutton, so far as the quality of protein is concerned (Jha *et al.*, 1991). Raw seed powder is an essential ingredient of the baby foods in China, which has a strong system of indigenous medicine. It has about 78 percent carbohydrate mainly in the form of starch of very minute dimension. *Makhana* is propagated by left seeds and also by transplantation. The organic matter remaining at the pond bottom mineralizes during next summer and is made available to the succeeding crop as good manure during its grand growth period.

Singhara is the second most significant edible aquaphyte, next to *Makhana*, with a potential to provide employment to the people. Fishing community sustains itself through fish – *Makhana* and *Singhara* cultivations. *Singhara* is widely used as a non-cereal diet during rituals and fasts. It is specially offered during *Chhath* festival. Singhara is held as one of the most productive aquaphyte which could be accounted for the presence of assimilatory roots in this plant. It is richer than *Makhana* in its nutrient value. The two spined *Trapa natans* var. *bispinosa* has how replaced the previous four spined *quadrispinosa* variety. Fresh Singhara kernel after peeling off the fruits is row or boiled from used. Singhara is also used as holy 'Prasad' at pilgrimages sites. The dried kernel of Singhara is available in market along with its flour.

Scirpus articulatus (Khubahi) is the third significant aquatic macrophyte that has an organized business and is sold in the north Bihar market as *'Ramdana'*, apparently on account of its similarity with the pops of real 'Ramdana' (*amaranth*). The ripened inflorescence of '*Khubahi*' are collected from wild area after the rainy season is over and water logged areas become accessible to move on. Matured inflorescence are processed to yield the minute black matured seeds from which are obtained its pops after washing & heat treatment. *Khubahi* pops are one of the lightest and are given to patients of 'Chicken pox' for easy ingestion. Those consuming *Khubahi* pops need not articulate their jaws. The pops of Khubahi refers to the granular sweets of *Khubahi Ramdana* as sold in the market. The raw seeds of actual *Ramdana i.e.*, amaranth, a land plant is different form the seeds of *Khubahi*. The pops of amaranth and Khubahi which are difficult to be distinguished from their shaped and sizes. Green Khubahi plants are used as a favorite fodder to raise the milk yielding capacity of animals.

Nymphaea alba (Bhent) flowers are also used at pilgrimage site in the areas where this plant is abundantly available. In Mithila area a flower Bhent is offered on the occasion of Chautha – Chandra festival. Those observing facts consume it as non-cereal diet (Phalahar). Flower of Bhent is also used by local people in place of lotus flowers on this occasion of Deepawali.

Nelumbo nucifera (Lotus/Kamal) is the national flower of India. It is highly revered for its elegance. It is symbol of beauty, purity and eternity. Stagnant water bodies in this region were commonly known as kamal or *Purain*. Recent decades have witnessed a change of growing pattern of the erstwhile lotus ponds into *Makhana* ponds. While pink lotus is to be observed sporadically, white lotus is gradually becoming rarer. Lotus plants do persist in a water body with the rhizomes as perennating structure. Water droplets on lotus leaves are unable to wet the surface. This property of lotus has given rise to the concept of lotus effect. The leaves of *Nelumbo nucifera* afford an impressive demonstration of the self-cleaning phenomenon called "lotus effect" which is of great biological and technological importance (Barthlott and Neinhuis 1997) [1]. A garland of lotus flower offered to a deity inside a temple. Lotus flower, its aggregate fruit and matured ripened lotus fruits with seeds are also sold in this region. The dry seeds of lotus also sold in the Darbhanga market for use in rituals. Lotus seeds forming a component of *Hawan – Saamagri.*

Katra or Khus (*Vetiveria zizanioides*) is a multifaceted grass which finds mention in Mithila folk tales, songs and proverbs and provides a basis to the "*Sikki art"* in this region. Vetiver grows luxuriantly in the floodplains and to an extent helps combat the challenge of global warming. North Indian population of *V. zizanioides* spreads through seed propagation. People generally plant it on the bunds of crop fields to ensure protection against high floods. Keeping in view its economic potentials, farmers have now started cultivating Khus in the floodplains. An additional gain is made through plantation of Dhaincha (*Sesbania* sp.) in the inner waterlogged area alongwith Vetiver. A number of women *Sikki* artists in this region have earned national and international fame and this art has proved a significant tool in women's empowerment, more particularly in the rural parts of Mithila. Vetiver provides an evidence of demarcation of land plots. Vetiver strands separating two plots. Young leaves are commonly used by the cattle rearers as a fodder. Local people are in the habit of planting Vetiver hedge on the *mer/aari* (line of demarcation).

Table 2: Old and New *Sikki* Gadgets Carved by Vetiver Artists in Mithial Area (North Bihar)

Old gadgets	Modern gadgets
"Mauni"	Casserole
"Paut"	Soap-case
"Changeri"	Telephone box
"Phuldali"	Table mattress
"Virahara"	Coaster feeder
"Kothi"	Pen holder/Knife holder
"Mujela"	Trays & Bangle

Katra is intimately associated with Mithila culture which is apparent from the fact that it forms a component of rituals in the area. Farmers in remote rural areas still observe a proactive of *Katra* (Vetiver) worship as a sequel to the ancient method of land conservation. This grass is formally eulogized on the first and last Sundays in the bright fortnight of *Agrhayan* (Nov. Dec.) and *Baisakh* (April – May). Women folk in the villages take holy bath in the nearby river/pond and move in a procession to the site of Vetiver grass where they offer flowers, fruits and vegetables etc. They refrain from taking salt on every sunday between these two months. *Katra puja* is a part of the ancient practice of "Sun Worship" in the old civilizations. As corollary to the process, cow-dung and clay blocks *(Dhep)* are held as 'witnesses' and are also eulogized by offering rice, flower, betel leaves etc, this is symbolic of cow-dung being significant in improving the soil fertility. Women also the 'knots' on the Vetiver leaves asking for fulfillment of their worldly and trans-worldly desires by observing this ritual, sustenance of Vetiver is ensured (Jha and Goel 2006, Jha *et al.* 2011) [5, 10]. There is a practice of planting Vetiver at the 'ghats' (podiums) raised specially for performing the "Chhath Puja" (again a practice of "Sun Worship" in eastern part of Mithila. Devotees observing Ekadashi (performing fast on 1st instant of every fortnight as per Indian calendar month) plant Vetiver in their courtyard on the occasion of *"karma Dharma Ekadashi"* and worship the same.

Eichhornia crassipes is the most consipicuous aquatic invasive which have posed serious threat and affected the distribution of native flora and have altered the aquatic vegetation pattern. *E. crassipes* requires a huge investment on its clearing in a number of tropical countries. Water bodies in north Bihar get infested with the hyacinth weed *(E. crassipes*) which grows at an alarmingly high speed and doubles its biomass within a period of 12-14 days. The overarching hyacinth covering could be observed in the major tanks including, Harahi, Dighi Gangasagar, Mirzakhan Talab and several others in the Darbhanga town area and also in the rural parts. Such a situation exists in water bodies of other major towns including that of the famous Mothijheel in Motihari town. Fishermen have to make extra efforts to clear the pond surface for use of the water body for fishing purpose. The Govt. of Bihar has initiated steps to use the hyacinth biomass for generation of biogas and vermicompost. A hyacinth bridge was constructed by local people in Biraul sub-division of Darbhanga district over the river Kamala. Having waited for a long time for a cement/iron bridge, people took it upon themselves to construct this bridge to cross the river during flood period.

Fishermen in the Kusheshwarsthan wetlands have developed an innovative method of putting hyacinth to a beneficial use. This pertains to the raising of fishing shelterbelts as a means of capture fishing. *Chaurs* like Larail, Mahrail and others in the Kusheswarasthan wetland area could be seen having series of such shelterbelts spread over the big water bodies as picturesque beads. These shelter belts, locally called *Jhangs* are raised by encircling an area with bamboo poles & synthetic mats with hyacinth covered alongside. Young children collecting the aquatic leafy greens of Sarhanchi *(A. sessilis*) in the Larail chaur of Kusheswarasthan wetland in the month of Feb. – March. The big *chaurs* of 'Larail' and 'Mahrail' provide a picturesque scene of dozens of Jhangs interspersed as beads in the vast aquatic matrix.

Table 3: Economics of raising a hyacinth shelter belt (*Jhang)* in the water bodies of Kusheswarasthan in North Bihar, India.

S. No.	Items	Details
1.	Total duration	Six months – October to April
2.	Average area	176.51m^2 (One Katha) approx.
3.	Distance between two *Jhangs*	400m^2
4.	Costs involved on Rope, Net, Bamboopoles, Labour charges, Branches of trees, Transportation of hyacinth etc.	Initial round – Rs. 15,000.00 to Rs. 20,000.00 Subsequent round – Rs. 1,000.00 to Rs. 2,000.00
5.	No. of harvests	4 to 5 times at an average interval of 45 days.
6.	Catch per harvest	500 Kg (Average)
7.	Total harvest	200 Kg (Average)
8.	Net profit	Approx. Rs. 50,000.00
9.	No. of persons involved per Jhang	5 to 6
10.	Types of fishes captured	*Boari, Saura, Rohu, Bhaura, Katla, Tengra, Common carp*., etc.

Wetlands in the region witness a lush growth of emergent macrophytes as well. *Typha australis* commonly known as "Pater" in this region is used for providing raw material for the Pater mats. Bhaptiyahi village in Supaul district of north Bihar lying in between the two embankments of Kosi river has emerged as a major centre of Pater mats. It is mostly the

rural women who are engaged in this endeavour and earn livelihood out of Pater mat business. Subterranean parts of Pater are used as favorite fodder by the pig population in this region. There is a need of developing organized system for collection of Pater rhizome as fodder for the animals, more particularity for the pig population.

North Bihar wetlands witness the infestation of two types of invasive Sarhanchi species including *Alternanthera philoxeroides* and *A.* sessilis. Both these aquaphytes grow luxuriantly in the shallow water bodies of the region. Cattle rearers use *Sarhanchi a*s a green fodder almost throughout the year. Water bodies in the Darbhanga town area have a luxuriant growth of the two grasses. The sprawling growth of *A. philoxeroides* under full bloom (with white flowers) in a wetland of Darbhanga is commonly seen in waterbody. The unfolded yellow colour of *Sarhanchi* fronds regain, their green colour within two - three days under full sunlight condition after resumption of photosynthesis. Farmers feed this grass to their cattle by mixing the same with dry fodder in 1:1 ratio.

Asteracantha longifolia (Tal Makhanal/Gokhura) and *Ipomoea aquatica* (Karmi saag) are used as the prominent leafy greens. The neighboring state of Bengal has a more organized marketing system of these leafy greens where these are sold almost round the year at retail vegetable shops as *'Muthias'* (handful) number. Such practice of sale of these leafy greens as "*Muthias*" exists in this area (North Bihar). *Karmisaag (Ipomoea aquatica)* sold as Muthiyas handfuls in a Kolkata vegetable market in the month of June.

Conclusion

People in the region of north Bihar have adapted the practice of utilizing a number of aquatic plant species to their benefit. Aquaphytes like *Vetiveria zizanioides, Scirpus articulatus, Typha australis, Euryale ferox, Alternanthera sessilis, Asteracantha longifolia, Trapa bispinosa, Nelumbo nucifera, Nymphaea alba, Eichhornia crassipes and Ipomoea aquatica.* have since emerged as life-line of the region. People of this region also devise innovative methods to fulfill their diverse needs with their aquatic plant products.

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