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RESEARCH PAPER

Small-Scale Mehedi (*Lawsonia inermis* L.) Farming in the Central Bangladesh: A Promising NTFP-Based Rural Livelihood Outside the Forests

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Abstract Throughout the world ornamentation of body with mehedi (*Lawsonia inermis* L.) leaf paste, with the trade name 'henna body art' is becoming increasingly popular. The worldwide increasing demand of mehedi leaf encourages many countries to adopt commercial farming of the plant. Farmers living in central Bangladesh recently commenced small-scale mehedi farming, primarily with the purpose of meeting national demand. A total of 182 farmers are engaged in mehedi farming and a study was conducted among 36 of them (a 20% random sample) to explore indigenous management techniques, marketing, livelihood potential and constraints of the enterprise. Farming was reported to be the major primary occupation of the study area. An average of 0.05 ha land of the respondents was used for mehedi cultivation, which constituted 16.7% of their average farm land. The farmers applied their own indigenous technology in every aspect of the farming, using branch cuttings as the only propagation material. The financial analysis indicated that mehedi farming is a profitable and attractive option for rural livelihoods [with an estimated net present value of Tk (Bangladeshi currency unit, 1 US $ = 68 Taka (as of May, 2009).) 179,500 for 0.1 ha plantation]. However, the enterprise faces several constraints, including absence of a nursery for supplying

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planting materials, storage and effective marketing facilities, available capital for investment, improved technology, and above all, government support. If the government extends cooperation by assisting farmers with training, technology, credit and market development, mehedi farming could become an important revenue-earning enterprise in the small-scale cottage sector of Bangladesh.

Keywords Henna body art · Indigenous knowledge · NTFP · Mehedi · Bangladesh

Introduction

Lawsonia inermis L., family Lythraceae, is a perennial shrub with local name varying between regions of the world, including mehedi, mendi or mehendi, henna, henne, al-khanna, al-henna, maruddhaani, gorintaaku, Jamaica mignonette, Egyptian priest and smooth lawsonia (BodyArtSupply 2009). The species attains an average height of 3–4 m, and is an evergreen with opposite, oval-lanceolate, entire and glabrous leaves (Drury 1873). Preferring hot climates for growth, it is indigenous to the area between the Islamic Republic of Iran and northern India (Green 1995), North Africa, the Arabian Peninsula, the Middle East and South Asia (Cartwright-Jones 2006). Rao et al. (2005) informed that mehedi grows best in tropical savannah and tropical arid zones, in latitudes between 15° and 25° N and S, and produces highest dye content in temperatures between 35 and 45°C. It can also occupy frost-free Mediterranean scrub zones, although it does not develop maximum dye content without high summer heat. The optimal soil temperatures range for germination is 25–30°C. It does not thrive where minimum temperatures are below 11°C and temperatures below 5°C will kill the plant (Rao et al. 2005).

From ancient times, mehedi has been employed as a cosmetic dye for hair, skin and nails and it has acquired a particular significance in Islamic culture (Green 1995). Cartwright-Jones (2006) reported its mention in the King James Version of the Holy Bible, the Old Testament, by its Latin name, camphire. Mehedi contains various aliphatic constituents, terpenoids, sterols, naphthoquinone derivatives, phenolic constituents, tannins, coumarins, xanthones and flavonoids (Ali 1996). Oyedeji et al. (2005) identified 36 components in *L. inermis* leaves from Nigeria, the major part (80.4%) of which was constituted by essential oils. The dye molecule, lawsone, is primarily concentrated in the leaves, and is in the highest levels in the petioles (Singh et al. 2005), ranging from 0.5 to 1.5% in dried, powdered leaves (Simon et al. 1984).

When dried, mehedi leaves are pulverized, wetted and applied to the skin for half an hour or more; lawsone breaches cells, penetrates and stains keratin in skin, hair and nails, just as the liquid from a teabag penetrates and stains cellulose in a white cotton tablecloth (Cartwright-Jones 2006). During the last two decades, mehedi art (popular as henna body art) has emerged from South Asia, the Levant, the Arabian Peninsula and North Africa into the popular culture of the USA, Canada, Europe and the UK (Maira 2000). Such body art with mehedi leaf paste is popular as adornment for weddings and other celebrations in South Asia, the Middle East and

Africa, and there is text and pictorial evidence that it has been used for adornment for over 5,000 years. There is documentation from archeologists that in ancient Egypt mehedi was used to stain the fingers and toes of Pharaohs prior to mummification (Cartwright-Jones 2006).

Mehedi has also been used medicinally (Chevallier 1996; TattooBug 2009) the leaves act as cooling agent on burnt skin, and it has antiseptic, astringent, antibacterial and antifungal properties. It is considered to aid in healing acne, boils, burns, bruises, fevers, heat rashes, skin rashes, warts and athlete's foot. It is also an antispasmodic, i.e. it has relaxing properties. It has been used for scalp treatment, to increase hair growth and reduce hair loss. The 'henna' of commerce is the dried leaf of mehedi, an aqueous extraction which provides a dye that can range in colour from black through blonde to red. Prior to the widespread availability of synthetic dyestuffs, it was also employed as a dye for textiles and leather-making.

Mehedi is a highly welcomed non-timber forest product (NTFP). In local, urban, national and international markets, forest goods contribute substantially to national economic growth. The NTFP sector is been estimated to generate over a billion dollars annually and is growing rapidly, perhaps faster than the timber industry (Wilkinson and Elevitch 2000). As a NTFP, mehedi makes a significant contribution in the economy of many countries. Green (1995) reported that world production of mehedi is substantially greater than the volume in international trade (estimated to be at least 9,000 tons of dried leaf), owing to the high level of domestic usage in many growing countries. The major exporters are India, Pakistan, Iran, the Sudan and Egypt. Other small-scale exporters include the Niger and Yemen. The major importers are the Islamic countries of the Near East and North Africa. Green argued that any future major growth in global consumption is likely to occur in Asian countries with a strong Islamic culture and growing populations. This new demand could be met in several cases by increased domestic production. Production in India, Pakistan and Iran is extensive rather than intensive and there is a high demand for 'henna' on the domestic markets. In several North African countries, however, intensive production systems are practiced. In the Persian Gulf market, black henna generally commands twice the price of red henna and during 1992 prices ranged from approximately US $250/ton for the lowest grades to US $700/ton for top grades of Indian and Pakistani black henna. Under rainfed conditions for dense planting the dried leaf yield in the first year is about 200 kg/ha while over the second, third and fourth years the yield normally ranges from 1,000 to 1,500 kg/ha. With irrigation and heavy fertilizer treatment, plus three harvests a year, yields in excess of 2,000 kg/ha can be obtained in the peak productivity years (Green 1995). Kumar et al. (2005) reported the production of 5–7 kg of leaves per year from mature mehedi plants.

As a cosmetic plant, mehedi is considered an alternative to chemical tints. The orange dye obtained from the leaves is used in Bangladesh for dying hair, eyebrows, fingernails and palms during ceremonials and festivals (Pasha 2004). The hue of mehedi is reflected through the hair while enhancing the hair's natural colour. It acts as a conditioner; the outermost layers of hair are softened by the sealing action of leaf ingredients. Mehedi gives the hair a polished look and protects it from the sun and air pollution. It can also be used on beards. Mehedi in the West is most

commonly used to dye hair, but with the new popularity of tattoos, the art of mehedi is considered a safe, painless and non-permanent alternative form of body ornamentation (Ghani 1998).

Miah and Rahman (2004) reported the availability of mehedi as a plantation shrub in the rural homesteads of Bangladesh, having some religious and ceremonial uses, while Chowdhury et al. (2009) described it a sacred—and the most cared-for species in the Muslim community—of the country. Although its cultivation has been restricted to the homestead level and specific to the Muslim community, recently mehedi has been cultured commercially in some areas of central Bangladesh.

A study of medehi was carried out to assess the potential for increased production and rural income generation from medehi growning in Bangladesh. The study was conducted in Keraniganj Upazilla of Dhaka district, to identify mehedi management practices and contribution to rural economy, and to assess the prospect for small-scale cottage enterprise, based on its leaves.

The Study Site

The study was conducted at Keranigonj upazilla (sub-district) of Dhaka district in central Bangladesh over a period of 7 months from February to August 2007. Keranigonj upazilla (sub-district) of Dhaka district in central Bangladesh is the only area of Bangladesh where mehedi is commercially cultivated. Keranigonj is situated 15 km far from Dhaka city, and covers a total area of 167 km^2, between 23°36′ to 23°47′ N latitude and 90°13′ to 90°29′ E longitude (SRDI (Soil Resource Development Institute) 1997) (Fig. 1). The area is in the new Brahmaputra alluvial geological region with plain to slightly undulating topography. Soils are clay-loam to clay with grey to deep grey colour (Brammer 1965). Keranigonj has a tropical monsoon climate with an average temperature of 19.4°C and annual average rainfall

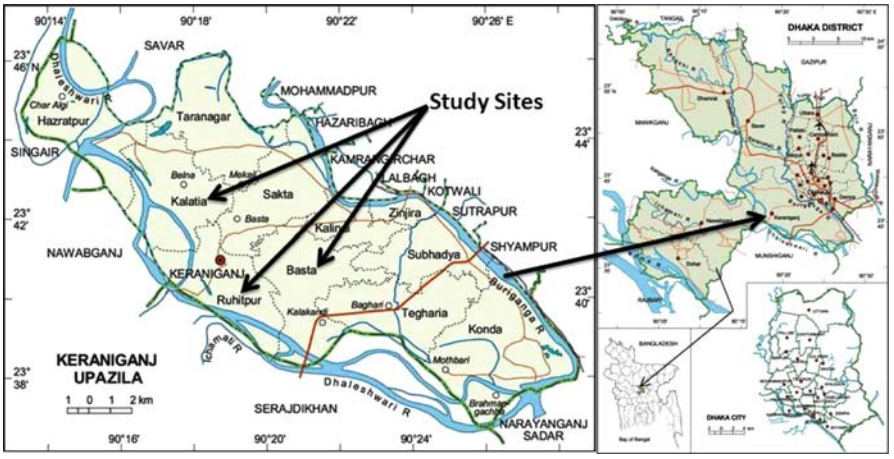

Fig. 1 The map of Dhaka district and Keranigonj upazilla showing the study sites (adapted from Banglapedia 2004)

of 2,098 mm. Mid-November to February is the coolest and driest period, March–May are the hottest months and June to mid-September is the most rainy and humid period (SRDI (Soil Resource Development Institute) 1997). According to the census of 2001 the population of the upazilla was 603,114 with a literacy rate of 51.8% (BBS (Bangladesh Bureau of Statistics) 2007).

Research Method

Out of the 12 unions of Keranigonj upazilla, mehedi is cultivated at three, viz. Basta, Ruhitpur and Kalatia. A preliminary socio-economic survey was carried out to ascertain the important socio-economic parameters of the study area and to select the respondents for detailed study. The three unions were visited at this stage and interviews conducted using a structured questionnaire; group discussions were held with key informants in the villages, including members of local government, local leaders, religious heads and the owners of tea stalls which the farmers use for meetings and recreation. After this preliminary survey, socio-economic parameters of potential value for the study were chosen and checked by further discussion with the key informants. A total of 182 farmers were found to cultivate mehedi; among them 36 were selected randomly for the study following a sampling intensity of 20%.

A semi-structured questionnaire was developed for face-to-face interviewing of the farmers, supplemented by direct observation of the mehedi farms. Questions were included to assess the land allocated for cultivation of mehedi, propagation materials, silvicultural techniques, contribution of mehedi to the household economy, and problems faced in mehedi farming. All the sample members agreed to be interviewed because the interviews were conducted in the afternoons, during the farmers' leisure time, when they were most available and receptive to questions. The farmers welcomed the study, considering it would attract the attention of government and NGOs to their medehi farming, and perhaps a new avenue would be opened with assistance in terms of credit, technology and marketing. The data once gathered, were processed using MS-Excel.

Results and Discussion

Basic Socio-Economic and Demographic Features of the Farmers

The average size of respondent families was 5.4, and the literacy rate of 64.4%. About 57% of the sample household members were male. All the respondents were male, and the average age was 36 years. Since all the respondents were Muslims—as a religious norm the female family members have to maintain *pardah*, or remaining unseen from the unknown male visitors, which is strictly followed particularly in rural areas of Bangladesh (Chowdhury et al. 2007)—the females did not participate in interviews. But the male respondents involved them in answering questions when necessary. The average number of income-earning members per

respondent household was 1.6 and the total earning members constituted 29% of the total respondent household.

The average landholding by the farmers was 0.3 ha. This includes their own land and land rented from others including homesteads, agricultural land and other fallow land. The major economic activities of the study area were centred on farming (the primary occupation of 72.2% of respondent households), while involvement in jobs and businesses occupied 25 and 2.8%, respectively, of the remaining primary occupations (Table 1). The average annual household income of the respondents was Tk 160,500, and the contribution of income from primary occupation was 77.1%. Farming involved production of various crops, including rice, jute, vegetables and mehedi, the latter accounting for 16.7% of the average farm area. Most of land is unsuitable for mehedi cultivation because it becomes

Table 1 Basic socio-economic and demographic features of the respondents

Socio-economic and demographic parameters	Relative frequency (%)
Gender	
Male	57
Female	43
Age class (years)	
0–10	16
11–20	23
21–30	26
31–40	17
41–50	12
51–60	6
>60	2
Education	
Illiterate	35.6
Primary	38.7
Secondary	24.2
Higher Secondary	1.5
Primary occupation	
Farming	72.2
Job	25
Business	2.8
Secondary occupation	
Business	13.9
Job	11.1
None	75
Average annual income (1000 Tk)	
Total	160.5
Primary	124.8
Secondary	35.7

submerged during the rainy season, and mehedi cannot survive in waterlogged conditions.

Almost all the members of respondents' families were involved in mehedi production. Collection of planting materials, selection and preparation of planting sites and sale of mehedi leaves were reported to be carried out by males only, while other cultural operations were performed by males, females and children. The farmers reported that they hire day labourers only during the preparation of planting sites and leaf harvesting because these operations are more difficult than others.

The Farming Pattern of Mehedi Cropping

Branch cuttings, generally about 30 cm in length, were used as the only propagation materials for mehedi in the study area, and were collected from disease-free and vigorously grown mother plants producing huge branches and larger sized leaves.[1] It was found that almost most respondents (83%) used their own farm as the source of planting materials, some collected cuttings from neighbours and relatives.

According to the respondents, the best time for planting cuttings is early monsoon (July) because mehedi plants have high water demand in the initial stage of growth. Moderately high land, free of trees and with good drainage is cultivated to control weeds. The land is fertilized with organic manure before planting the cuttings. Respondents reported survival rates of 90–95% in the rainy season, compared with 60–65% in other seasons. Three planting patterns—single line (24% of respondents), triangular (19%) and rectangular (57%)—were reported. However, most (89%) considered the rectangular pattern is best because it provides a dense look with high volume of leaves in a limited space. Branch cuttings were planted at 30–45 cm spacing within rows and 60 cm between rows, i.e. 1,200 plants in 0.1 ha of land. It was considered that plants would be stunted if spaced at less than 30 cm between individuals, and that the crop would not be financially viable if the spacing exceeded 45 cm.

After planting, mehedi plants require sufficient water in the first dry season; any deficiency may result in crop failure. The farmers were reported watering every 3 days. During watering, care was taken to ensure that water does not become stagnant at the base of plants and cause wilting. Because weeds can severely affect mehedi plantation establishment, all respondents reported carrying out weeding every month. Fertilizing mehedi farms with both chemical and organic fertilizer is a common practice in the study area. Farmers fertilize their farms six times a year, each time applying a mixture of urea and triple super phosphate (TSP), and mixture of cow-dung and mustard cake at a rate of 50 and 80 kg respectively, to every 0.1 ha of plantation area.

[1] Mehedi can also be grown from seed; Morgan (2005) described the Pakistani farmers' ploughing mehedi seeds into moist, fertile beds to germinate them, after which seedlings are transplanted into larger fields.

Harvesting and Marketing of Mehedi Leaf

The first harvest was reported to be carried out 6 months after planting when the leaves begin to turn yellow. This corresponds with the suggestion of Cartwright-Jones (2006), who advocated the harvesting of mehedi within the month of new growth or when the leaves begin to turn yellow. In the study area, the farmers were found to harvest mehedi leaves twice in the first year and four times in successive years. The branches were cut into pieces of 45–60 cm length and bundled. Each bundle contained 4–5 branches and 40 such bundles were obtained from a single plant in every harvest, decreasing to 30 bundles in the third year. Harvesting was done manually using a *dao* (a sharp curved thin knife). Mehedi was reported to be planted with a target of 3 years leaf production before replanting.

After harvesting, the farmers were found to carry the mehedi branches to local markets for sale to middlemen. Each bundle was reported to be sold at Tk 0.70. Some portion from the local market was also reported to be sold directly to the local retailers, vendors and consumers for use as raw mehedi. The middlemen supplied the bundles to the factory owners and processors. The factory owners sometimes purchased bundles directly from farmers in local markets. In Bangladesh, mehedi is generally processed for domestic consumption only. After processing, the entrepreneurs supplied the finished product in the form of leaf paste in plastic tubes to the traders who further supplied to the retailers for selling to end-use consumers (Fig. 2).

Financial Performance of Mehedi Farming

Growing mehedi and sale of leaves was evaluated as a financial investment project, the parameters of the analysis being as set out in Table 2. The financial parameters were divided into capital outlays, operating costs and project revenues. It was assumed that the land is not owned by the growers, but rather is rented for the 3-year crop rotation. Operating costs include annual expenditure on fertilizer, growth hormone, pesticide, weeding, harvesting and transport.

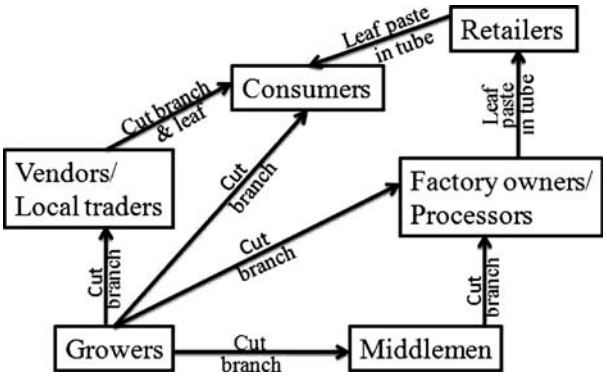

Fig. 2 The flow chart of marketing of mehedi products in the study area

Table 2 Financial parameters for mehedi farming in 0.1 ha land over a rotation of 3 years

Area planted (ha)	0.1
Cost of tools and equipment (Tk)	1500
Annual land rent (Tk)	6000
Up-front land rental period (years)	3
Planting cost (Tk/ha)	1600
Fertilizer cost (Tk/ha)	5600
Growth hormone cost (Tk/ha)	2400
Pesticide cost (Tk/ha)	2400
Weeding cost (Tk/ha)	2400
Harvesting cost (Tk/bundle)	0.0125
Transport cost (Tk/bundle)	0.125
Opportunity cost of own capital (%)	6%
Borrowing rate (%)	8%
Proportion of capital outlay borrowed	100%
Inflation rate (%)	7%
Weighted average cost of capital (%)	0.93%
Planting density (plants/0.1 ha)	1200
Number of harvests, year 1	2
Number of harvests, year 2	4
Number of harvests, year 3	4
Yield, year 1 (bundles/plant/harvest)	40
Yield, year 2 (bundles/plant/harvest)	40
Yield, year 3 (bundles/plant/harvest)	30
Mehedi price (Tk/bundle)	0.7

Local practice is that a payment for land hire for all 3 years is made at the beginning of the first year, hence this was treated as a capital outlay, together with purchase of tools and planting costs. It is assumed that these outlays are met from borrowed funds, at an interest rate of 8%. The annual inflation rate in Bangladesh typically runs at about 7%, and, applying a multiplicative model between borrowing and inflation rates, the inflation-adjusted cost of capital is just under 1%.

NPV is chosen as the indicator of financial performance as it takes into account both cost and return components over time (Alam et al. 2009). A *constant price* analysis is applied, on the assumption that costs and returns increase at the same rate over time. No allowance is made for farmers' labour in this analysis, the net present value (NPV) being in effect a return on labour inputs.

In the study area, growing 0.1 ha plantation of mehedi was found to be financially viable, with a NPV of Tk 279,500 (Table 3). It was also reflected by the opinions of the respondents; all of them believed that mehedi farming is a profitable option for securing their livelihoods.

Problems in Mehedi Farming

The respondents were asked about the problems in mehedi farming, and raised various issues, including the lack of nursery facilities, storage and effective

Table 3 Cash flow table and financial performance criteria for mehedi farming

	Year			
	0	1	2	3
Plant and equipment (Tk)	1,500			
Land rental (Tk)	18,000			
Planting	1,600			
Total capital outlays (Tk)	21,100			
Leaf quantity (bundles)		96,000	192,000	144,000
Fertilizer (Tk)		5,600	5,600	5,600
Growth hormone (Tk)		2,400	2,400	2,400
Pesticides (Tk)		2,400	2,400	2,400
Weeding cost (Tk)		2,400	2,400	2,400
Harvesting cost (Tk)		1,200	2,400	1,800
Transportation cost (Tk)		12,000	24,000	18,000
Total operating costs (Tk)		26,000	39,200	32,600
Crop revenue (Tk)		67,200	134,400	100,800
Net cash flow (Tk)	−21100	41,200	95,200	68,200
Net present value (Tk)	179,487			

marketing facilities, capital investment, and improved technology. Moreover, they identified the lack of support by the extension service of the Department of Agriculture and Forest Department towards mehedi farming as one of the prominent problems. The Forest Department already has forestry nurseries at each of its local management units to establish plantations of various species in the countrywide barren state-owned land. Individual entrepreneurs and NGOs working with social forestry have also established seedling nurseries throughout the country (Ahmed et al. 2008). The number of private nurseries in Bangladesh has increased from a few hundred to about 4,000 during the last 6 years (Safa 2006). But no organization has come forward yet to establish nurseries for mehedi farming for which farmers often face with a lack of high quality planting materials during planting seasons.

Mehedi leaf loses its freshness after 1 day, so it needs some extra care to store for long periods. Due to the lack of storage facilities, farmers sometimes face problems with unsold leaves. The respondents reported that middlemen, not the farmers themselves, make considerable profits from the farming. This is because of the existing poor marketing systems as well as the farmers' lack of marketing knowledge and market information. Ahmed et al. (2008) observed that the small-scale nature, poor financial position and scattered distribution of the farmers pose serious problems for marketing the products, while Bakht (1984) argued that marketing difficulties are a leading constraint to the development of such cottage enterprises as mehedi farming. With the increasing popularity of 'henna body art' in western countries, research is being carried out in mehedi producing countries to improve its quality in various aspects (Cartwright-Jones 2006). But unfortunately, the farmers of Bangladesh do not have access to any improved technology regarding this plant and its farming.

Concluding Remarks and Policy Priorities

Mehedi farming has great potential to contribute to the rural livelihoods of Bangladesh. This is almost a new farm crop in Bangladesh, although cultivation of mehedi for commercial purposes is a long-timed episode in many countries. In Bangladesh, mehedi growers do not have any improved technology and employ their own indigenous knowledge in every aspect of its cultivation. However, the net return from mehedi leaf sale is satisfactory at the individual grower level and contributes a large share to annual household income. But the farmers face some problems in farming mehedi originate from neglect on the government's behalf. Considering it as a latent NTFP, if the government extends cooperation to mehedi farming, this would obviously assist to secure rural livelihoods; as stated by Neumann and Hirsch (2000) the contributions of NTFPs to rural incomes are consistently higher than national-scale estimates.

It seems that mehedi farming can add a new dimension in the national economy of Bangladesh. Mehedi can be grown almost all over the country, because the land and climate are suitable for its cultivation. This study has revealed that farmers generally possess the effective management techniques for medehi farming. However, it is necessary to conduct research to develop improved propagation methods and increase dye quality of leaves, to achieve higher production. Recently, in setting research priorities in forestry, research on various facets of medicinal plants has been given high impetus by the Bangladesh Academy of Science (Ahmed 2009). With its worldwide recognition as a medicinal plant, mehedi can be included in the list of priority plants for which research is warranted, which was ignored in research projects implemented in the past. Like many other NTFP-relevant projects, the state Forest Department can promote a scheme of mehedi farming involving local people with all-out support in terms of training, technology, raw materials, supervision and marketing. Alternatively, the Department of Agriculture may take these initiatives. Whoever it is, the responsible authority needs to prioritize the storage and marketing of leaves as most of the NTFPs were found to cater to low-income markets that emerge as the major bottleneck for expanding the enterprise (Nair 1995). Ros-Tonen and Wiersum (2003) argued that the increasing incorporation of rural areas into external commercial networks can create scope for improving livelihoods on the basis of NTFPs production. Non-government organizations (NGOs) may come forward to assist in market development. It could thus be a promising small-scale cottage enterprise in Bangladesh with a capacity of fulfilling both domestic and international demands.

References

Ahmed FU (2009) Executive Director, Aranyak Foundation (a joint institution of the Government of Bangladesh and the United States), Dhaka, personal communication

Ahmed R, Hasan MS, Halim MA, Alam M (2008) State of urban nurseries in Bangladesh: a case study from the northeastern region. Small Scale For 7(3–4):275–283

Alam M, Furukawa Y, Harada K (2009) Agroforestry as a sustainable land use option in degraded tropical forests: a study from Bangladesh. Environ Dev and Sustain. doi:10.1007/s10668-009-9186-3. http://www.springerlink.com/content/242j70x28667wq72/?p=9e8a429f7c7441c0a2db43a2e887e6b4&pi=28

Ali M (1996) Potential of *Lawsonia inermis* L. as a medicinal plant. Hamdard Med 39(4):43–48

Bakht Z (1984) Entrepreneurship in Bangladesh rural industries. Bangladesh Dev Stud XII(1-2):25–58

Banglapedia (2004) Banglapedia-the encyclopedia of Bangladesh. Asiatic Society of Bangladesh, Nimtali, Ramna, Dhaka

BBS (Bangladesh Bureau of Statistics) (2007) Area, population and literacy rate by upazilla/thana-2001. Bangladesh Bureau of Statistics, Ministry of Planning, Govt. of the Peoples' Republic of Bangladesh. Available via Dialog. http://www.bbs.gov.bd/. Accessed 17 March 2009

Brammer H (1965) Reconnaissance soil survey: Dhaka district. Department of Soil Survey, Government of the East Pakistan, Karachi

BodyArtSupply (2009) Henna, mehndi and bindi. Available via Dialog. http://www.powerpassion.nl/tattoo-and-body-piercing/henna-mehndi-bindi.html. Accessed 8 March 2009

Cartwright-Jones C (2006) Developing guidelines on henna: a geographical approach. TapDancing Lizard Publishing, 4237 Klein Ave., Stow, Ohio, USA

Chevallier A (1996) The encyclopedia of medicinal plants. DK Publishing, New York

Chowdhury MSH, Uddin MS, Haque F, Muhammed N, Koike M (2007) Indigenous management of patipata (*Schumannianthus dichotoma*) in the rural homesteads of Bangladesh. J Subtrop Agric Res Dev 5(1):202–207

Chowdhury MSH, Koike M, Muhammed N, Halim MA, Saha N, Kobayashi H (2009) Use of plants in healthcare: a traditional ethno-medicinal practice in southeastern rural areas of Bangladesh. Int J Biodivers Sci Manag 5(1):41–51

Drury CH (1873) The useful plants of India. International Book Distributors, Dehra-Dun

Ghani A (1998) Medicinal plants of Bangladesh with chemical constituents and uses. Asiatic Society of Bangladesh, Dhaka

Green CL (1995) Natural colourants and dyestuffs: a review of production, market and development potential. Non-woof Forest Products No. 4. Food and Agriculture Organization, Rome

Kumar S, Singh YV, Singh M (2005) Agro-history, uses, ecology and distribution of henna (*Lawsonia inermis* L.). Henna cultivation, improvement and trade 11–12. Central Arid Zone Research Institute, Jodhpur

Maira S (2000) Henna and hip hop: the politics of cultural production and the work of cultural studies. J Asian Am Stud 3(3):329–369

Miah MD, Rahman MM (2004) The effect of religious sub-culture on the stock and diversity of the village forests in the floodplain area of Bangladesh. In: Baumgartner DM (ed) Proceedings of human dimensions of family, farm, and community forestry international symposium, March 29-April 1, 2004. Washington State University, Pullman, USA

Morgan A (2005) Henna farming in Pakistan. Available via DIALOG. http://www.hennapage.com/henna/encyclopedia/growing/Pakistan/. Acccessed 18 March 2009

Nair CTS (1995) Income and employment from non-wood forest products. In: Durst PB, Bishop A (eds) Proceedings of regional expert consultation beyond timber: social, economic and cultural dimensions of now-wood forest products in Asia and the Pacific. Food and Agriculture Organization, Rome

Neumann RP, Hirsch E (2000) Commercialization of non-timber forest products: review and analysis of research. Center for International Forestry Research, Bogor

Oyedeji AO, Ekundayo O, Koenig WA (2005) Essential oil composition of *Lawsonia inermis* L. leaves from Nigeria. J Essent Oil Res. July/August 2005. Available via DIALOG. http://findarticles.com/p/articles/mi_qa4091/is_200507/ai_n14901654. Accessed 11 March 2009

Pasha MK (2004) Dye plant. In: Islam S (ed) Banglapedia: the national encyclopedia of Bangladesh. Asiatic Society of Bangladesh, Dhaka

Rao SS, Regar PL, Singh YV (2005) Agrotechniques for henna (*Lawsonia inermis* L.) cultivation. Henna cultivation, improvement and trade 25–27. Central Arid Zone Research Institute, Pali-Marwar

Ros-Tonen MAF, Wiersum KF (2003) The importance of non-timber forest products for forest-based rural livelihoods: an evolving research agenda. Paper presented at the GTZ/CIFOR International Conference on Livelihoods and Biodiversity held at Bonn, Germany, 19–23 May 2003

Safa MS (2006) The role of NGOs in improving social forestry practice: do they promote livelihood, sustainability and optimal land use in Bangladesh? Small Scale For Econ Manag Policy 5(2):207–229

Simon JE, Chadwick AF, Craker LE (1984) Herbs-an indexed bibliography 1971–1980: the scientific literature on selected herbs aromatic and medicinal plants of the temperate zone. Archon Books, Hamden

Singh M, Jindal SK, Kavia ZD, Jangid BL, Khem C (2005) Traditional methods of cultivation and processing of henna. Henna, cultivation, improvement and trade 21–34. Central Arid Zone Research Institute, Jodhpur

SRDI (Soil Resource Development Institute) (1997) Land and soil resource use directory: Keranigonj upazilla, Dhaka district. Soil Resource Development Institute, Ministry of Agriculture, Government of the Peoples Republic of Bangladesh, Dhaka

TattooBug (2009) History of Henna. http://www.tattoomanufacturers.com/henna/henna-history.html. Accessed 10 March 2009

Wilkinson KM, Elevitch CR (2000) Non-timber forest products for pacific islands: an introductory guide for producers. Permanent Agriculture Resources, Holualoa