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Waste Land Management by Utilising Minor Fruit Crops

*Shiny Priscilla N, Akino A and Malathi
Faculty of Horticulture, SRM College of Agricultural Sciences,
Chengalpattu -603201, Tamil Nadu, India
*Corresponding Author's email: sn5516@srmist.edu.in

Another critical focus in sustainable horticulture is waste land management owing to growing pressure on agricultural lands and substantial soil degradation due to erosion, salinity, and improper management of lands. A sustainable and practical way to reclaim these abandoned and degraded lands is through the cultivation of minor fruits like Bael, Wood Apple, Karonda, Ber, Jamun, Phalsa, and Mulberry. These plants demonstrate natural hardiness and adaptability under drought conditions in degraded lands with extensive rock outcrops and/or salinity that repel mainstream commercial farming ventures. Their extensive root systems prevent soil erosion and increase soil organic content to promote soil rejuvenation and stabilization. Plant growth conditions solely emphasize vegetative propagation strategies such as budding and grafting to retain high-value traits and accelerated fruit production. Although highly hardy and adaptable to adverse conditions, these plants require proper management strategies like annual pruning systems (annually), particularly critical in Ber and Phalsa varieties, supplemental irrigation when fruits ripen to increase their quantity and quality. Another critical angle through which minor fruits outperform their more expensive counterparts is through substantial stabilization in degraded lands with intricate effects in improving soil health along with extreme nutritional value in equal measure without substantial.

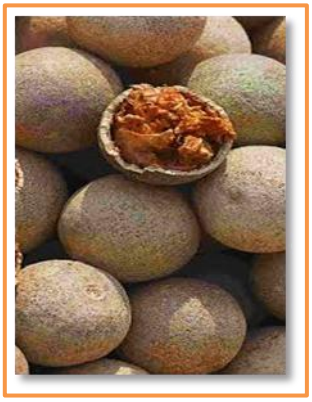
Keywords: Waste land management, Sustainable Horticulture, Karonda

Introduction

Waste land management has emerged as a crucial focus in sustainable horticulture because of the growing pressure on arable land, heightened population needs, and extensive land degradation resulting from soil erosion, salinity, drought, deforestation, and improper land practices. A significant area of land in numerous regions is still underused or empty due to low soil fertility and adverse environmental factors. An efficient and eco-friendly approach to transform these degraded lands into valuable resources is by growing minor fruit crops. Crops like amla, ber, custard apple, jamun, karonda, bael, wood apple, tamarind, phalsa, fig, star fruit, dragon fruit, passion fruit and mulberry possess natural hardiness, drought resistance, and can flourish in poor, rocky, or dry soils where many key cash crops typically struggle. Their extensive root systems assist in stabilizing soil, minimizing erosion, and enhancing soil stcture and organic content gradually, rendering them perfect for ecological restoration. Alongside environmental advantages, small fruit crops offer considerable economic and nutritional benefits, as they need minimal inputs, produce fruit in challenging conditions, and see rising market demand for fresh use and processed goods. Farmers can generate extra income, improve food security, and promote biodiversity by incorporating minor fruit species into wastelands, all while restoring degraded ecosystems. Therefore, applying minor fruit crops for waste land management presents a sustainable, cost-effective, and enduring solution that fosters environmental sustainability, rural economies, and efficient utilization of natural resources.

Production Technology of Minor Fruit crops

Bael: Bael (***Aegle marmelos***) a Rutaceae family crop with a chromosome number of 18, a sacred and medicinal fruit tree native to India, thrives under specific production technologies that ensure optimal yield and fruit quality. Cultivation typically begins with the selection of superior cultivars like Pant Aparna, Pant Shivani, or Narendra Bael 5, which are propagated vegetatively, often through bud grafting (especially patch budding), to maintain genetic purity and achieve early. While it tolerates a wide range of soils, well-drained, sandy loam soil with a pH range of 5 to 8 is ideal .The trees are hardy and drought-resistant, requiring moderate irrigation, primarily during the dry season and fruit development stages, but sensitive to waterlogging. Planting is usually done at a spacing of 8x8 meters in square systems during the monsoon season. Mature orchards benefit from an annual application of balanced NPK fertilizer and regular organic manure to support growth and heavy fruiting. Pests like the lemon butterfly and fruit fly, along with diseases such as gummosis and leaf spot, are managed through integrated pest management practices, including sanitation and appropriate fungicidal sprays. Pruning is minimal, focusing on removing dead or diseased branches. Bael trees typically start bearing commercially viable fruit 4-5 years after grafting, with the hard-shelled fruits harvested manually when they turn yellowish-green. Post-harvest handling is critical due to the fruit's hard rind, with processing focused on developing value-added products like jam, candy, and squash.



Wood apple: Wood apple (***Limonia acidissima***) is a crop in Rutaceae family with chromosome number of 18. This crop is natural hardiness and adaptability to dry, semi-arid, and wasteland conditions. It thrives in tropical and subtropical regions, tolerating a wide range of soil pH (from 5 to 10) and requiring low maintenance once established. Propagation is primarily done by seed, although commercial cultivation favours vegetative methods like patch budding and softwood grafting in March or July-August. Grafted or budded plants are preferred as they are dwarf, more precocious, and start bearing fruit in 3-4 years, compared to seedling trees which can take 7-15 years. HB-10 a variety released from Marthawada Agriculture University (MAU), Parbhani, Mirzapuri, K A standard planting distance of 8m x 8m with $1m^3$ pits is recommended, filled with farmyard manure (FYM), sand, and topsoil to facilitate water harvesting. Young plants require initial irrigation for establishment, especially during the summer months; mature trees are largely drought-resistant but benefit from annual application of 25-50 kg FYM split into two doses during the monsoon season for better fruit size and quality. Training of young plants with stakes to form a proper framework is necessary, and annual pruning in December-January involves removing only dry, dead, or criss-crossing branches. The tree is relatively pest and disease resistant, with only occasional issues like leaf-eating caterpillars managed by hand-picking or insecticides. Fruits mature 8-10 months after flowering and are harvested by hand-picking when the rind color turns pale and a hollow sound is produced upon tapping, typically between October and March depending on the region. Post-harvest, the hard rind allows for storage at room temperature for up to 10 days, or longer under refrigeration, before being processed into various value-added products like jams, jellies, and juices.

Karonda: Karonda (***Carissa carandas L.***) belongs to the **Apocynaceae** family, originated in the **Indian subcontinent,** and has a chromosome number of **2n = 22** production involves cultivating a hardy, drought-tolerant, spiny evergreen shrub well-suited for tropical and subtropical climates and marginal soils, including saline or sodic types. Propagation is commonly done through seeds, which start bearing fruit in two to three years, though vegetative methods like semi-hardwood cuttings, air layering, and budding are preferred for

genetic uniformity and faster yield (2-3 years). Planting is typically carried out during the monsoon season (June-August) in well-drained soil, using pits filled with farmyard manure (FYM). While established plants require minimal irrigation, young plants need watering at regular intervals, and supplementary irrigation during flowering and fruit development can enhance yield and quality. Pruning is generally minimal, focusing on removing unwanted or diseased branches to maintain shape and encourage growth, with main training done in the initial two years. Plants start yielding around the third year, with mature plants producing 4-15 kg of fruit annually, harvested manually in 3-4 pickings when the fruits change color from green/white to red or dark purple, depending on the variety (e.g., Pant Manohar for pickle, Konkan Bold for table purpose). The fruits are rich in iron and vitamin C and are used for pickles, jams, jellies, and sauces.

Ber: Ber production technology involves specific practices tailored to this hardy, drought-resistant fruit tree (***Ziziphus mauritiana***), often called the "poor man's apple," which thrives in arid and semi-arid regions. The process begins with propagation, primarily through vegetative methods like 'T' or shield budding onto a hardy rootstock such as (*Ziziphus rotundifolia*) to ensure true-to-type, early-bearing plants. Planting usually occurs at the onset of the monsoon season in pre-dug pits filled with farmyard manure and soil, with adequate spacing to allow for proper tree growth. A critical annual practice is heavy pruning during the hot, dry, dormant season (May-June in Northern India) to remove old growth and induce new shoots, as fruits are borne on the current season's growth. While established trees are drought-hardy, irrigation is beneficial during fruit development (October-February) to improve fruit size and yield. Integrated pest management is necessary to control common issues like fruit flies and powdery mildew, using methods such as sanitation, tolerant varieties, and judicious application of pesticides and fungicides. Fruits mature 150-175 days after flowering and are harvested when they reach a proper golden-yellow color, after which they are graded and can be processed into various value-added products like candy, jam, and pickles to enhance market value and extend shelf life.

Star fruit: Star fruit (***Averrhoa carambola***) belongs to the **Oxalidaceae family**, originates from **Southeast Asia/Indonesia,** and has a diploid chromosome number of **2n=22 or 24,** making it a tropical fruit from the wood sorrel family known for its distinctive star shape when sliced. production requires specific techniques tailored to its tropical and subtropical origins to ensure a healthy, high-yielding crop. Trees thrive in warm, humid conditions with full sun and require well-draining, slightly acidic soil, ideally with a pH between 5.5 and 6.5, as they are sensitive to high-pH or waterlogged conditions that can cause nutrient deficiencies. Commercial growers typically use vegetative propagation methods like grafting or budding to ensure consistent fruit quality and earlier bearing, with grafted trees often producing fruit within 2 to 4 years, compared to 4-5 years for seed-grown plants. Planting involves preparing appropriately spaced holes and incorporating organic matter and micronutrients like iron and manganese into the soil. Ongoing management includes consistent deep watering during dry periods, regular fertilization (typically a balanced formula applied every 4-6 weeks for young trees, less frequently for mature ones), and annual pruning to shape the tree, manage height for easy harvesting, improve air circulation, and remove unhealthy branches. Pest management is

crucial, with fruit flies, scales, and fungal diseases being common issues often mitigated by fruit bagging, organic sprays like neem oil, and maintaining proper air flow in the canopy. Harvesting is done by hand when fruits develop a yellow color with slightly green ribs for the commercial market, or fully yellow/orange for peak sweetness when consumed fresh, to maximize shelf life and quality.

Tamarind: Tamarind production technology involves adopting improved agricultural practices to ensure sustainable cultivation and efficient post-harvest processing. The trees are well-suited to tropical and subtropical climates and can tolerate drought conditions, making them ideal for semi-arid regions. Propagation is commonly done through vegetative methods like softwood grafting or patch budding to ensure true-to-type plants and earlier yields, compared to the traditional seed propagation. Orchards are established with recommended spacing (e.g., 10x10m for seedlings or denser planting for grafted varieties) and require practices such as regular irrigation during dry periods, application of farmyard manure and specific NPK regimens, and early training and pruning to develop a strong canopy. Fruits are typically harvested when the pods turn brown and become brittle, usually from March to April in India, and are then sun-dried to separate the pulp from the shell and seeds. The harvested pulp can be stored or further processed into various value-added products like juice concentrates, jams, candies, and powders using both traditional and mechanical methods such as dehullers and deseeders to enhance efficiency and hygiene.

Jamun: Jamun trees are hardy and can grow in a wide range of soils, including saline and sodic soils, but thrive best in deep loam, well-drained soils. The tree requires a tropical or subtropical climate with dry weather during flowering and fruit setting. Propagation is generally done through vegetative methods like softwood grafting, veneer grafting, or budding, as seedling trees take 8-10 years to bear fruit, while grafted ones start in 4-5 years. The best time for planting is during the monsoon season (July-August). Pits of 1m x 1m x 1m size are prepared and filled with a mixture of topsoil and well-rotted farmyard manure (FYM). Irrigation is crucial, especially for young plants which need 6-8 irrigations a year. Mature bearing trees require about half the number of irrigations, primarily during May and June for proper fruit development and ripening. Fertilizer application includes an annual dose of about 50-80 kg of FYM per bearing tree, along with NPK application adjusted according to soil fertility to prevent excessive vegetative growth which can delay fruiting. Regular pruning is generally not needed, but removing dry and crossed branches helps maintain canopy health. Common pests like whiteflies and leaf-eating caterpillars can be managed with proper sanitation and appropriate sprays. Fruits ripen in June-July and are harvested by hand-picking to avoid damage, as they have a short shelf life of 3-4 days under normal conditions.

Phalsa: Phalsa (*Grewia subinaequalis*, syn. *Grewia asiatica*) belongs to the **Tiliaceae family (now often Malvaceae),** is **native to India and Southeast Asia**, and typically has a **diploid chromosome number (2n) of 36,** though some sources note variations like 2n=18 for certain types, with its fruits prized for refreshing juices. Production is a low-input, high-potential horticultural practice suitable for arid and semi-arid regions of the Indian subcontinent. The plant is a hardy, drought-tolerant, deciduous bush that thrives in areas with distinct winter and summer seasons and requires ample sunlight for fruit development. It

can grow in a wide range of well-drained soils, including marginal and moderately alkaline lands, but performs best in rich loamy soil with a pH of 6.1 to 6.5. Propagation is primarily done by seed, as the seedlings are generally true to type and the method is cost-effective. Freshly extracted seeds from ripe, dark-colored fruits should be sown in nursery beds in July-August, germinating within 15-20 days. Seedlings, typically 8-12 months old, are transplanted to the main field during the dormant period in January-February or during the rainy season. A common planting distance is 2.5 to 3.0 meters apart, but high-density planting systems can accommodate over 2000 plants per hectare for increased yield. A critical aspect of phalsa cultivation is annual pruning, which is essential because the fruits are borne on the current season's new growth. Bushes are typically pruned to a height of 75-100 cm during mid-winter (December-January) when they are dormant. This practice encourages vigorous new shoots and ensures a heavy yield of marketable fruit. While phalsa is drought-tolerant, occasional irrigation is necessary for optimal fruit quality and size, particularly at 15-20 day intervals during the flowering and fruiting period (March to June). Fertilizer application, including well-rotted farmyard manure (10-15 kg per bush) after pruning and split doses of nitrogenous fertilizers, enhances plant health and production. Flowering occurs from March to May, with fruits ripening from April to June, about 45-55 days after fruit set. Harvesting is labour-intensive and requires multiple hand-pickings every 2-3 days over a month, as not all fruits ripen simultaneously. Fruits turn from green to crimson red or dark purple when fully ripe and are highly perishable, with a shelf life of only 24-48 hours under ordinary conditions. Post-harvest handling must be careful to avoid bruising, and immediate pre-cooling and storage at 0-5°C can extend shelf life to about a week. Average yields range from 2 to 4 kg per mature bush, which can be enjoyed fresh, or processed into popular sherbets, juices, and squashes.

Mulberry: Mulberry trees (***Morus*** spp.) are hardy and adaptable, thriving in well-drained, fertile soil with a slightly acidic to neutral pH (6.2 to 7.0) and full sun exposure (at least 6-8 hours daily). While trees can be grown from seed, which may take 5-10 years to fruit, commercial or home fruit production generally uses grafted varieties or propagation via semi-hardwood cuttings to ensure true-to-type plants that yield fruit within 1-2 years. Planting should be done in early spring or late fall, considering the mature size of the tree and the mess from falling ripe fruit. Spacing for fruit trees is typically wider than for leaf production, allowing ample room for growth and harvest access. Regular care involves consistent watering, especially during flowering and fruiting stages, without overwatering which can cause root decay. A balanced NPK fertilizer should be applied in early spring, with organic matter like farmyard manure or compost mixed into the soil annually to enhance fertility. Pruning is crucial for shaping the tree, improving air circulation, and stimulating fruit production, as flower and fruit buds develop on second-year-old growth. Pruning is best performed during the dormant season (late winter) to remove dead or diseased branches and maintain a manageable structure for harvesting. Pest and disease management involves monitoring for common issues like powdery mildew and using appropriate organic or chemical controls, avoiding sprays during blooming to protect pollinators. Harvesting occurs when fruits are plump, juicy, and have reached their full color (white, red, or black depending on the variety), typically in late spring or early summer. Because mulberries ripen non-simultaneously and are delicate with a short shelf life, multiple pickings are necessary. A common and efficient method for large quantities is the "shake and catch" method, where a sheet or net is placed under the tree and ripe branches are gently shaken to release the berries.

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