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Aloevera propagation & economic feasibility

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Abstract
Aloe vera Linn. (Liliaceae) is a medicinal plant and has a number of curative properties along with wider adaptibility. Vegetative propagation has not enough potential for supplying market demand. However, via *in vitro* propagation makes possible the mass production of Aloe plants. There is a lack of production of Aloe leaf to meet the industry demand. So, it is necessary to undertake large-scale cultivation of Aloe. A single plant produces 2–3 offshoots in a year which is not sufficient for undertaking commercial cultivation. *In vitro* propagation or tissue culture of plants holds tremendous potential for the production of high-quality plant-based medicines. This can be achieved through different methods including micropropagation. From the economic point of view Aloevera cultivation gives more profitability with a low resource requirement as well as it starts to give return from second year onwards. This is a hardy perennial tropical plant that can be cultivated in drought prone areas and is one of the crops whose potential is yet to be exploited, despite being identified as 'a new plant resource with the most promising prospects in the world.

Keywords: Aloevera, adaptibility, micropropagation, turnover, marketing

Introduction
Aloevera (Aloe barbadensis) is a popular medicinal plant (Cera *et al*., 1980; Gui *et al*., 1990; Meyer & Staden, 1991) [7, 11, 16] and has been used worldwide in pharmaceutical, food, and cosmetic industries, or in traditional medicine, due to the plethora of biological activities of some of its primary and secondary metabolites (Campestrini *et al*., 2006) [6]. Belonging to Liliaceae family. It is known as Ghrit Kumari, Kunwar Pathu and Indian Aloe. It derives its name "Aloevera" from Arabic word Alloeh which means shining bitter substance. It is a perennial plant, growing to the height of 1½ - 2½ ft. Its leaves are long and thick, juicy with a wheel like phyllotaxy. The inner part of leaf which contains gel and latex are used for preparing various medicines. It contains Vitamins A, B1, B2, B6, B12, Folic Acid, Niacine (Jamir *et al*.1999) [12]. Medicines prepared from Aloevera used for burns and sunburn, as well as a variety of skin diseases like eczema, pruritus, psoriasis, acneetc. (Eshun *et al.* 2004) [10] (Reynolds & Dweck, 1999) [18]. The A. Vera leaves are used to treat bacterial and fungal skin diseases (Yadav & Singh, 2010) [21]. Aloe gel consists of 99.3% water. The remaining 0.7% is composed of solids with glucose and mannose constituting for a large part. These sugars together with the enzymes and amino acids in the gel give the special properties as a skin care product (Agarry *et al.*, 2005) [1]. Modern use of A. Vera was first documented in the 1930s to heal radiation burns (Collins, 1935) [8]. It is stem less plant with average height of 24cm-39cm having thick and fleshy leaves. It is propagated through Vegetative propagation which seems to be easy and convenient. There is a lack of production of Aloe leaf to meet the industry demand (Aggarwal & Barna, 2004) [2]. So, it is necessary to undertake large-scale cultivation of Aloe. It is indigenous to Africa and Mediterranean countries. This is a hardy perennial tropical plant that can be cultivated in drought prone areas and is one of the crops whose potential is yet to be exploited, despite being identified as 'a new plant resource with the most promising prospects in the world'. Aloe contains two classes of A loins & nataloins, which yield picric and oxalic acids with nitric acid, and do not give a red coloration with nitric acid; and Barba loins, which yield aloeticacid (C7H2N3O5), chrysammic acid (C7H2N2O6), picric and oxalic acids with nitric acid, being reddened by the acid (Vogler *et al.* 2002) [20].

Soil
It is grown successfully in marginal to sub marginal soils having low fertility. The plants have tendency to tolerate high pH with high Naand K salts (Barcoft *et al.* 2003). However, it is observed that itsgrowth was faster under medium fertile heavier soil such as black cotton soils of central India. Though well drained loam to coarse sandy loam soils with moderate fertility and pH upto 8.5 are preferred for its commercial cultivation.

Varieties
Several species of the genus have been in use under the common name of Aloe, *viz*. *Aloe vera* Linn. *A. barbadensis* Miller, *A. ferox* Miller, *A. chinensis* Baker, *A. indica* Royal, *A. perryi* Baker, etc., belonging to family Liliaceae. Among these, *A. vera* Linn. syn. *A. barbadensis* Miller is accepted unanimously as the correct botanical source of Aloe. Some of the cultivated varieties of aloevera are IC111271, A. perfoliata, A. vul-garis, IC111269, A. indica, A. littoralis, IC111280 (Taxon, US Dept. of Agriculture, 2005)

Land preparation
The soil should not be disturbed too deep as the root system of Aloe does not penetrate below 20-30 cm. depending upon the soil type and agro climatic condition, 1-2 ploughing followed by leveling may be done. Field may be divided into suitable sized plots (10-15 m × 3 m) considering the slope and source of irrigation available (Jones *et al.* 2000) [13].

Propagation
It is propagated by root suckers or rhizome cuttings. For this purpose, medium sized root suckers are identified and carefully dug out without damaging the parent plant at the base and directly planted in the main field (Das *et al.* 2004) [9]. Suckers should be planted in July – August during monsoon season to get better field survival and subsequent growth of the plants. However, under irrigated condition, planting can be done around the year except in winter months (November – February).
Apart from cutting or by root suckers propagation, micropropagation can be practiced for propagation of Aloevera. Vegetative propagation has not enough potential for supplying market demand. However, via *in vitro* propagation makes possible the mass production of Aloe plants which was done by utilizing growth regulators' for proliferation of A. vera. The shoot tips and auxiliary buds of A. vera were cultured in the Murashige and Skoog (MS) medium. The maximum number of shoots was obtained on the medium supplemented with 1 mg/L IAAþ4 mg/L BAP and 0.2 mg/L IAAþ0.8 BAP mg/L. Rooting was also achieved in the same media composition proliferation of shoot. The acclimatized plants showed 100% of survival. Rooted plantlets were transferred to garden soil, compost, and sand in the proportion of 1:1:1, respectively, after hardening. The regenerated plants looked healthy, and they were morphologically similar to that of stock plants (mozghan *et al.* 2014).

Manuring
The crop responds well to the application of farmyard manure and compost. During the first year of plantation, FYM @20 t/ha is applied at the time of land preparation and the same is continued in subsequent years. Besides vermicompost @2.5 tonnes/ha can also beapplied.

Spacing and Planting
Suckers are planted in about 15 cm deep pits made just at the time of planting at 60×60 cm a part. After planting of suckers, the soil around the root zone must be firmly pressed and drainage must be made proper to avoid water stagnation. About 28000 – 34000 suckers are needed for one hectare planting.

Irrigation
Aloe can be successfully cultivated both under irrigated and rainfed conditions. Provision of irrigation immediately after planting and during summer season will ensure good yield. However, the plants are sensitive to water logged conditions. After 40 days or so weeding and earthing up are done. Ear thing up is also practised after top dressing of Fertiliser. Aloe vera is slightly tolerant to drought, but very sensitive to water stagnation. Therefore, proper drainage is more important than irrigation. As per need light irrigation during drought is enough.

Plant protection
Not much problems of insect pests and diseases have been observed in this crop from any part of the country. However, mealy bug, anthracnose and leaf spots have been reported from some parts of the country.

Harvesting and Yield
Leaving the fresh and young leaves from the top, older outer leaves are generally harvested. The plants can be removed manually or with the help of a tractor-drawn disc harrow or cultivator. New leaves grow from the center upward. Off shoots are grown spontaneously next to the mother plant. Crop is ready to harvest after 18 months of sowing. Economic yields are obtained in 5 years after that it needs replanting. In India, the average yield for organically grown Aloe is about 12 tonnes/ha (on fresh weight basis).

Post-harvest management and Processing
Aloe should be processed within a couple of hours of harvest so as to prevent oxidation. The Aloe leaf consists of three layers, a. the outer thick green rind, b. viscous, jelly-like mucilage layer into which the vascular bundles, attached to the inner surface of the rind, protrude and c. the fillet consisting of hexagonal structures containing the fillet fluid. The Pericyclic cells located at the top of the vascular bundles contains the "Yellow Sap" or "Latex". This sap is rich in alone and similar anthraquinones having laxative properties. Aloe leaves are processed either by the traditional hand filleting method or by whole leaf method (Biswas *et al.* 2010) [5].
The traditional hand-filleting method of processing of aloe leaves was developed to avoid possible contamination of the fillets with the yellow sap. In this method, the lower one inch of the leaf base (the white part attached to the large rosette stem of the plant), the tapering point (2-4") of the leaf top, and the spines located along the leaf margins are removed by a sharp knife. The knife, is then introduced into the mucilage layer below the green rind avoiding the vascular bundles and the top rind is removed. The bottom rind is similarly removed, and the rind parts, to which a significant amount of mucilage remains attached, are discarded. Another portion of the mucilage layer accumulated on the top of the filleting table is of critical concern because of the highest concentration of potentially beneficial aloe constituents in this layer. The

materials of the mucilage layer, subsequent to their synthesis, are distributed to the storage cells (cellulose reinforced hexagons) of the fillet which is extracted in this process.

The hand-filleting method is very labour intensive and therefore machines have been designed and employed which attempt to simulate the Hand-Filleting technique. In the whole leaf method, the base and tip are removed as previously delineated and then the leaf is cut into sections and ground into a particulate slurry. The material is then treated with chemicals which breaks down the hexagonal structure of the fillet releasing the constituents. These constituents are filtered by means of a series of coarse and screening filters, or passage through a juice press to get rid of the rind particles. The expressed juice is passed through various filtering columns which remove the undesirable laxative agents. This process, performed properly, can produce a constituent rich juice, virtually free of the laxative anthraquinones.

Indoor cultivation

Generally, Aloe grows openly in the field, but it can also be grown indoors in pots kept in sunny southern or eastern window. Containers have to be filled a quarter full with drainage material and compost consisting of two parts loam and one part coarse sand, broken bricks and crushed limestone, with a bit of bone meal added. Plant should be potted in the spring and water ed carefully until established (BBC Gardening). During the summer, water can be given as soon as the soil is dry, but from September to March very little water is needed, just enough to prevent the leaves from shriveling. Over watering will kill the plant. Well-rooted plant will benefit from occasional applications of dilute liquid fertilizer in the summer. Large plants, however, do need an occasional top dressing of fresh soil in each spring; any loose soil should be removed and replaced with new. The drainage holes should be plugged up.

Economics

Expenditure to be incurred for Aloevera cultivation normally amounts to aboutRs.1,10,000 / ha. The expected income with a yield of about 110 – 115 quintal would be about Rs. 340,000/ha. The net profit would be about Rs.230,000 /ha/year. In addition to monetary benefit, social benefit would be anormous. Better management can results in much higher income and net profit.

Table 1: According to the studies conducted by Biswas *et al*. 2010 [5].

S. No.	Item	Cost (Rs.)
1.	First year expenditure	2,25,000.00
2.	Second year cost	75,000.00
3.	Third year cost	75,000.00
	Total cost in three years	3,75,000.00
	Estimated income in three years (Price @ 15 Rs./Kg profit at the end of three years)	25,59,000.00 21,84,300.00
4.	Profit/Year/H act	7,19,766.00

Market Scenario

The current global turnover of raw Aloe leaves amount upto US $ 70-80 million dollar which is expected to grow @ 35 % in the next 5 years. For Processed derivative & value added products, current global trade is estimated at around US $ 1 billion & US $ 25 billion respectively (Biswas *et al.* 2010) [5].

Conclusion

Aloe Vera Cultivation and Marketing in India has a good scope. This will increase in the coming days even more because of the medicinal properties of Aloe Vera. The best feature of this Aloe Vera is its adaptability as it can be grown any type of Climatic Conditions with very less input requirement. As we all know, it can easily thrive in the hot extreme conditions. *Aloe vera* is a medicinal plant and due to its extensive medicinal, nutraceutical and other uses its enjoy a great demand in the market across the globe. The major markets for *Aloe vera* and its extracts are Australia, US and the entire Europe. Given the exponentially growing demand for it in the international market, *Aloe vera* presents the finest commercial opportunity among the various medicinal plants. India is among the few countries gifted with the unique geographical features essential for cultivation of *Aloe vera* and other high potential medicinal plants. *In vitro* propagation or tissue culture of plants holds tremendous potential for the production of high-quality plant-based medicines. This can be achieved through different methods including micropropagation

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