

## **Harnessing Neem (*Azadirachta indica* A. juss): A Sustainable Approach to Natural Farming**

### **Abstract**

This review explores the rich concept of natural farming and the varied usage of neem in natural farming. Neem plant holds an important position in the rich tradition of India. The various portion of neem tree are used as insecticide, fertilizer, manure, soil conditioner etc. In recent era the major challenge is to increase the food production without harming the environment. Neem is considered ecofriendly, biodegradable, least persistence and also economic. Neem based formulations forms a considerable constituent of Natural farming. Successful results of application of neem based formulations in natural farming will provide adoption of cost effective technology to the farming community.

Key words: *Azadirachta indica*, Neem, Natural farming, B:C ratio

### **Introduction**

Natural farming is a chemical free traditional farming system which integrates crops, trees and livestock with functional diversity. The term 'Natural Farming' was introduced by Fukuoka, a Japanese Farmer and Philosopher in his book 'The One-Straw Revolution' in the year 1975 (De, 2022). Green Revolution technology transformed India from food scarce country to food surplus but also led to unfavourable influences like soil degradation, biodiversity losses, increasing cost of cultivation etc. Indiscriminate use of chemical fertilizers and pesticides and declining crop productivity alongwith uncertain market conditions and climate change contributed into unremunerative agriculture. The significant environmental and financial crisis in the farming community has given rise to emergence of new models of agriculture. Various options to the existing agriculture practices have evolved over the decades. [32-34] An urgent need have come up for an efficient farming practice that is local, resilient and adaptable (Ravindra et al., 2022). Natural Farming is a farm practice which can address significant apprehension of farmers of increasing cost of cultivation. It envisions ecological or regenerative agriculture that forbids application of any kind of chemicals to soil biosystems. There is promotion of multicropping, year round soil cover, addition of formulation containing cow dung and urines to activate the microorganisms in the soil system which envisions a total chemical free farming (Kumar et al., 2020). Integrating non pesticidal management practices prevents pests and diseases from causing damage to crop. Few curative measures like appropriate application of botanical concoction or natural solutions are there in natural farming to protect from pests and diseases (Ravindra et al., 2022). Neem plants are considered as a power house of bioactive chemicals and a strong option of insect pest control. Neem based botanical concoctions form an substantial part of natural farming because of their less harmful nature and ease for biodegradability. Neem tree is found throughout the country and its pest-control properties have been established on the Indian subcontinent. Neem has cropped up as the finest choice for natural farming among the numerous biopesticides and disease-control plants (Adusei and Azupio, 2022).

## Plant description

*Azadirachta indica* (Neem) originated in India and Myanmar and because of its numerous health benefits referred as “The village pharmacy” or “Divine tree” (Islas et al.,2020). It is a small to medium-sized evergreen tree with thick fissured bark that ranges in colour from dark gray to red inside. Its sap is gummy and colorless. The leaves are glabrous pinnate, long (20–40 cm) and light green in colour. The flowers are fragrant and white or pale yellow in colour. The fruits are tiny (1–2 cm) in size and range in colour from greenish to yellow. The tree has extensive lateral roots and a deep tap root system (Usharani et al.,2019). It can reach upto a height of 12-24 m high at altitudes between 50 and 100 m and needs 130 mm of sufficient rainfall per annum to grow normally. Today Neem is acknowledged as a gift of nature with lot to offer in terms of resolving issues of global agriculture, environment and public health. It contains compounds with demonstrated antiseptic, antiviral, antipyretic, anti-inflammatory, anti-ulcer and antifungal uses in the seeds, bark and leaves. Neem contains a variety of ingredients having therapeutic uses. Azadirachtin is the active constituent derived from neem tree and is known to be the major insecticidal ingredient. Neem is reported to induce sterility in insects by averting oviposition and disturbing sperm production in males. It acts as an antifeedant, repellent, and repugnant agent (Chaudhary et al.,2017). Some other active ingredients in neem includes nimbolinin, nimbin, nimbidin, nimbidol, sodium nimbinatate, gedunin, salannin, and quercetin(Sharma and Vaquil,2018). Neem has showed efficacy in suppressing the feeding sensation in insects, at concentrations even less than 1 parts per million which contributes to its antifeedant properties (Isman et al., 1991). Plant diseases like collar rot disease of chickpea is reported to be controlled by application of neem leaf amendment(Khan et al.,2020).Neem acts as a nematocide to kill nematodes without any deleterious effect on earthworms (Gajalakshmi and Abbasi,2004). Neem tree is also referred as “agroforestry tree of India” because of its great adaptability,use as shelter belt and ability to provide an alternate income source to the villagers (Pande and Tarafdar,2004).

## Neem application in Natural farming

The growing demand of natural farming concept has revived the neem based agroforestry system in India. Neem can be used as manure,urea coating agent,soil conditioner,fumigant and in management of crops and pests (Lokanadhan et al, 2012). Neem is used in different formulations of plant protection of Natural farming (Sharma,2022) and are described as below:

a. **Neemastra:** Neemastra is applied for control of plant diseases and to eliminate insects or larvae that consume plant leaves and suck plant sap. It is easy to prepare Neemastra and applied as an powerful pest repellent and bioinsecticide. The inputs needed are 200 litre water, 2 kg cow dung, 10 litre cow urine, 10 kg fine paste of neem leaves along with short branches.Neemastra helps in avoiding laying and hatching of insect eggs. It also act as antifeedant for sucking pests and early larval stages of lepidopteran pests (Ravindra et al.,2022). The effective performance of neem may be due to bioactive compounds like azadirachtin, nimbine, kemferol, thionemone etc. which are nematocidal in nature(Abbasi et al.,2005).

b. **Brahmastra:** It is prepared from leaves that possess specific alkaloids to repulse pests and control the sucking pests and caterpillars which are found in pods and fruits.

The inputs needed are 20 litre Cow Urine, 2 kg Neem leaves along with short stems or branches, 2 kg Karanj leaves, 2 kg Custard Apple leaves, 2 kg Datura leaves, 2 kg Castor leaves, 2 kg Mango leaves and 2 kg Lantana leaves. Brahmastra resulted in maximum feeding inhibition against *Agrotis segetum*. (Shiwani et al., 2022).

c. Agniastra: It acts as antifeedant against wide range of pests and utilized for controlling all sucking pests and caterpillars. The inputs needed are 20 litre cow urine, 2 kg neem leaves paste, 500 gm tobacco powder, 500 gm green chilli paste, 250 gm garlic paste. Owing to the presence of potent chemicals in neem, tobacco, chilli and garlic, Agniastra is considered as powerful botanical concoction and applied when all other options are ineffective (Ravindra et al., 2022).

d. Dashaparni ark: It is used as an alternative for Neemastra, Agniastra, and Brahmastra. Dashaparni ark helps in controlling various pests depending on the level of infestation. Inputs needed are 200 litre water, 20 litre cow urine, 2 kg cow dung, 500 grams turmeric powder, 10 grams Asafoetida, 1 kg tobacco powder, 1 kg chilly pulp, 500 gram garlic paste, 200 gram of ginger paste. Neem leaves also forms a part of wide range of botanicals of 10 leaves used in Dashaparni (Ravindra et al., 2022).

## Case Studies

Publication of natural farming's best practices alongwith the success stories are crucial for raising awareness, encourage adoption and fostering confidence among the farming community. Natural farming practices have been efficiently and successfully adopted by farmers across India and numerous success stories of application of neem in Natural farming practices has been documented in India (Patel et al., 2022). It is noticed that farmers have often developed their own techniques and methods for implementing the principles of natural farming. A majority of the farmers expressed that adoption of natural farming methods have led to reduced cost of cultivation, enhancement in yield with noticeable improvements in the health of farmers. Shri Kothapalli Shiva Ramayya of Kadapa district sprayed neemastra, dashaparni alongwith sour butter milk for control of pests and diseases in his farm. Shri Maaganti Chandraiah of Krishna district applied neemastra (2 times, 200 litre/ application, @20 days after transplanting & 40 days after transplanting) and sour butter milk (1 time, 8 litres in 150 litres of water, @30days after transplanting) for pest management in his crops. Smt T. Yamini of Nellore district who inspired female farmers to takeup natural farming applied neemastra 100 lit/acre at 25 days after transplanting in her farm. Shri Chauhan Vikramsinh Jesangbhai of Vadodara district cultivated vegetables through natural farming approach and used home prepared plant protection measures like neemastra, brahmastra, agniastra and dashaparni extracts in his field. Shri Deda Ram of Pali district used neem trees for farm boundary plantation which provided soil with manure and acted as a raw material for preparing natural pesticides. Natural farming practices enhanced the income of the farmers as evidenced by higher benefit cost ratio. Smt Mupalla Nirmalamma of SPSR Nellore district has grown citrus in her natural farming plot with reduced cost of cultivation and higher yield (Table 1). Sri B Ramakoteswara Rao of Kadapa district cultivated 22 different types of vegetables with reduced cost of cultivation under natural farming and produced seeds on his own (Table 2). Sri Dixit B Patel of Sabarkantha district has successfully grown banana by following natural farming methods and sorted, graded and marketed the produce directly to the end user (Table 3).

Table 1: Economics of citrus grown under natural farming and conventional farming

Parameter	Natural farming (0.4 ha)	Conventional farming (0.4 ha)
Crop	Citrus	Citrus
Cost of cultivation (₹)	18900	35100
Production (q)	48	45
Gross return (₹)	99100	76250
Net return (₹)	80200	41150
B:C	4.24	1.17

Table 2: Economics of vegetables grown under natural farming and conventional farming

Parameter	Natural farming (0.4 ha)	Conventional farming (0.4 ha)
Crop	Vegetables	Vegetables
Cost of cultivation (₹)	14500	21800
Production (q)	32	29
Gross return (₹)	51800	47500
Net return (₹)	37300	25700
B:C	2.56	1.17

Table 3: Economics of banana grown natural farming and conventional farming

Parameter	Natural farming(0.4 ha)	Conventional farming(0.4 ha)
Crop	Banana(G-9)	Banana(G-9)
Cost of cultivation (₹)	40000	175000
Production (q)	100	70
Gross return (₹)	400000	380000
Net return (₹)	360000	205000
B:C	9.00	1.17

### Challenges

There is a strong herbicidal or allelopathic activity in the extract of neem trees. Allelopathy is a biological phenomenon in which an organism produces one or more biochemicals that affect the growth, life cycle and reproduction of other organisms. These biochemicals are known as allelochemicals and can have beneficial (positive allelopathy) or detrimental (negative allelopathy) effects on the target organisms. Allelochemicals are present in almost all parts of the plant i.e. roots, stem, leaves and fruit (Vaithyanathan et al., 2014). Nimbolide B and nimbic acid B may be responsible for the allelopathic activity of neem (Kato-Noguchi et al., 2014). Neem bark and leaves exhibited allelopathic properties in different crops such as alfalfa, carrot, bean, rice, radish, sesame and also in numerous weeds by inhibiting germination and growth (Xuan et al., 2004). Soil microorganisms play a very key role in ecosystem processes, including the decomposition of organic matter and transport of major plant

nutrients(Madigan et al., 2011). Azadirachtin has also been reported to lower the load of soil and rhizosphere microorganisms(Sarawaneeyaruk et al.,2015). The neem active ingredients, particularly azadirachtin and nimbolide were found to inhibit nitrifying microorganisms.The hindering effect of the neem leaf extract on nitrification led to ammonium toxicity.The neem extract did not elevate the growth and yields of lettuce but imposed deleterious effects on the lettuce. Nitrogen deficiency accompanied by ammonium and aluminium toxicities drove the detrimental effects of the neem leaf extract on the lettuce(Sriraj et al.,2022).There are issues with storage of plant extracts such as neem as sunlight degrades their effectiveness as pesticides (El Shafie and Elmahy, 2012).

## Conclusion

The food security for the future generation need to be maintained by sustainable and viable approaches. Agro-ecological concept like Natural farming are becoming more and more relevant in the present context. Neem is a blessing for natural farming that aims to preserve the environment.Neem can be grown on the bunds of natural farming field and can improve the productivity of wasteland.Neem trees on field bunds can function as an effective windbreak and also grows well with fruit culture. Neem leaves makes an excellent mulch for conserving soil moisture and maintaining soil temperature and offers protection from plant diseases. Taking into account the sizeable quantity of material required for producing neem based products, large scale cultivation of neem could be done in marginal lands which are found not suitable for other crops. Neem is having the drought tolerance ability and commercialization of neem plants would generate income to sustain the livelihood of communities in semi-arid areas.Therefore there is need for more research to develop formulations with longer shelf life while retaining the desired efficacy. There is scope for research focussing on stability of neem formulations especially under field conditions.Concerned stakeholders with support of researchers and policy makers, should create more awareness on the need to embrace neem based formulations as safe pest management tools. So,it can be said that harnessing the potential of neem tree as crucial natural farming tool will contribute towards ensuring food and nutritional security of the planet.

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