

**Indian Farmer**

Volume 12, Issue 07, 2025, Pp. 371-378

Available online at: [www.indianfarmer.net](http://www.indianfarmer.net)

ISSN: 2394-1227 (Online)

**Original article****In-situ live and dead mulching of legumes: A valid substitute for brown manuring in natural farming****Amit A. Shahane***Assistant Professor (Agronomy), College of Agriculture (Central Agricultural University, Imphal), Kyrdemkulai, Meghalaya, India – 793 105**\*Corresponding author: [amitiari89@gmail.com](mailto:amitiari89@gmail.com)**Received: 07/07/2025**Published: 10/07/2025***ABSTRACT:**

The brown manuring (BM) is co-culture of different leguminous crops and knock down them to serve as nutritional need through biological nitrogen fixation (BNF) and weed management. As BM require knock down by herbicide (2,4-D), it will not match with principles of organic farming (OF) and more recent natural farming (NF). In NF mulching is important component of production system; while due to competitive use of all form of crop residue generated from agriculture, their availability is constrained. In this scenario, modification of BM as live and dead mulch will be worthy which involves replacing the herbicide by either uprooting or cutting crops or application of high concentrated solution of common salt (NaCl). As these BM crops produce high biomass, they will generate sufficient organic matter for mulch and are complementary to crops grown in NF due to their effect as weed management, sources of nitrogen and phosphorus and rapid rate of decomposition and improvement in soil organic carbon.

**Key words:** Mulch, *Sesbania*, sunhemp, cowpea, organic farming.

The natural farming (NF) is most recent form of agriculture promoted in India which is a public based intervention in production system and tested for different aspect such as calibration of methodology, comparison with other production system and generating knowledge about NF (Kumar et al, 2023; Duddigan et al., 2023). The NF is differing from OF in the sense that, in-situ input production is emphasized in NF with mandatory functional diversity of crops, trees and livestock. The concept of NF is actually given by Massnobu Fukuoka in his book 'One Straw Revolution' with the principles of no tillage, no fertilizer, no pesticide, no-weeding and no pruning; while different pioneer workers in India describe and add several location specific relevant component in NF as well as also suggested and tested modulation of component suggested in original form of NF which suite to location or crops. In Indian perspective such modulation and addition by different pioneer workers includes Pratap Agarawal (*Rishi Kheti*), Padm. Subhash Palekar (Zero budget natural farming), Sripad Dabholkar (Natueco-culture), Deshpande (Rishi- Krishi), K. Natarajan (Panchagavya farming), Vasant Paranjape (*Homa farming/ Agnihotra farming*), Narayana Reddy (Ecological farming),

Bhaskar Save (Gandhi of NF), Shri G. Nammalwaar (Tamil Nadu) and Shir Acharya Dewrat (Himachal Pradesh). Besides Indian perspective other type of farming evolved across the World matching with concept of NF includes biodynamic farming (Rodulf Staier), vermin-culture farming (Ms. Applechoff) and fertility farming (Newman turner). These all types of farming here and there are matching and are in confirming the NF components which indicate that NF is umbrella term which includes ecologically responsive farming derived and promoted traditionally over large part of the India. These different types are considered while deriving concept of NF and setting the component and principles and hence it will be worthy to study these traditional farming practices. The NITI AGOY is national agency defining NF as A chemical free traditional farming and considered as agro-ecology based diversified farming system which integrates crops, trees and livestock with functional bio-diversity. The key words such as traditional farming, agroecology, diversification, functional biodiversity are important to express types of practices, component and principles the present concept of NF will be going to have. The above mention keywords are well defined with respect to tis principles, components and practices and can be used to initiate the NF. There is growing attention to differentiate NF from OF (Shahane, 2024) in order to get distinct and separate recognition for NF (Table 1). Earlier NF is treated as a one types of organic farming with special emphasis on soil health through use of compost and microbial population. At present NF presented at different scientific forum (Anonymous, 2022; Anonymous 2022a) is much broader than NF presented as component of OF. Besides that, OF is well established with respect to product standards, certification protocols, market infrastructure and consumer awareness; while in NF these things need to be established separately. Hence besides differentiating the OF and NF, it will be also worthy to find the similarities between NF and other form of production practice (Table 2). This will have practical significance because of the fact that, practices and methodologies for NF will be calibrated and/ or formulated with the help of such similarities. Among the several similarities such as organic input, weed management, minimum/ zero tillage and pest management, the brown manuring as a source of crop nutrition, mulching and weed management is described herewith.

**Table 1.** Differences between natural farming and organic farming

Particular	Natural farming	Organic farming
Definition	Chemical-free traditional farming method and considered as an agro-ecology based diversified farming system which integrates crops, trees and livestock with functional biodiversity	Agrochemicals GMM crops and Antibiotics
Initiation	Farmer initiatives	Organic farming by default
Present status	Still in initiation status with lack of market initiatives	Specialized commercial farming.
Base knowledge and adoption	Mostly indigenous to India	Contribution from entire world

Components	<i>Homa</i> farming, Rishi farming <i>Panchagavya</i> farming, Zero budget natural farming and <i>Agnihotra</i> farming.	Biological farming, permaculture, eco-farming, alternative agriculture, integrated intensive farming system and biodynamic farming
Approach	Farming system based as crop, tree and animal are important component	Crops specific and not necessary to have tree and animal as component
Focus	In-situ and independent	Organic input irrespective of source/ origin
Weightage	ITK and public based interventions	Organic standards
Calibration and measurement	In-going processes	Done completely and availability of impact analysis information
Emphasis	Emphasis on soil health and integrated production system;	Emphasis on economic production to natural resource
Disturbances to natural resources	Less than organic farming	Desirable disturbances
Sources of nutrition	In-situ	Both in-situ and ex-situ
Processing of bio-inputs	Must and more finely done	Limited only up to decomposition
Plant protection	More dependence on in-situ methods	Both in-situ and ex-situ
Involvement of human activities	Lower	Higher
Commercialization of input-output.	Lower	Higher
User interface of the products	Not well defined	Well defined with price tag and authentication
Certification	Standards and procedure establishment; complex.	Well established standard and easy (as it is crop specific).
Potential	Yet to realise on economic terms	Export and domestic market

**Table 2.** Similarities of natural farming components and practices with other concepts and production systems

S. No.	Component of natural farming found similarity with other systems	Production system in which similarity is reported
1.	Green and brown manuring	Organic farming
2.	Legumes in crop rotation	
3.	In-situ and ex-situ rainfall water conservation	Farming system and integrated farming system
4.	Integration of crop, trees and livestock with functional diversity	
5.	Minimum tillage or zero tillage	Conservation agriculture
6.	Pest and diseases management methodologies	Indigenous technical knowledge (ITKs).
7.	Recycling and input reduction	Agro-ecology
8.	Biodiversity and synergy	
9.	Economic diversity	
10.	Soil health and animal health	

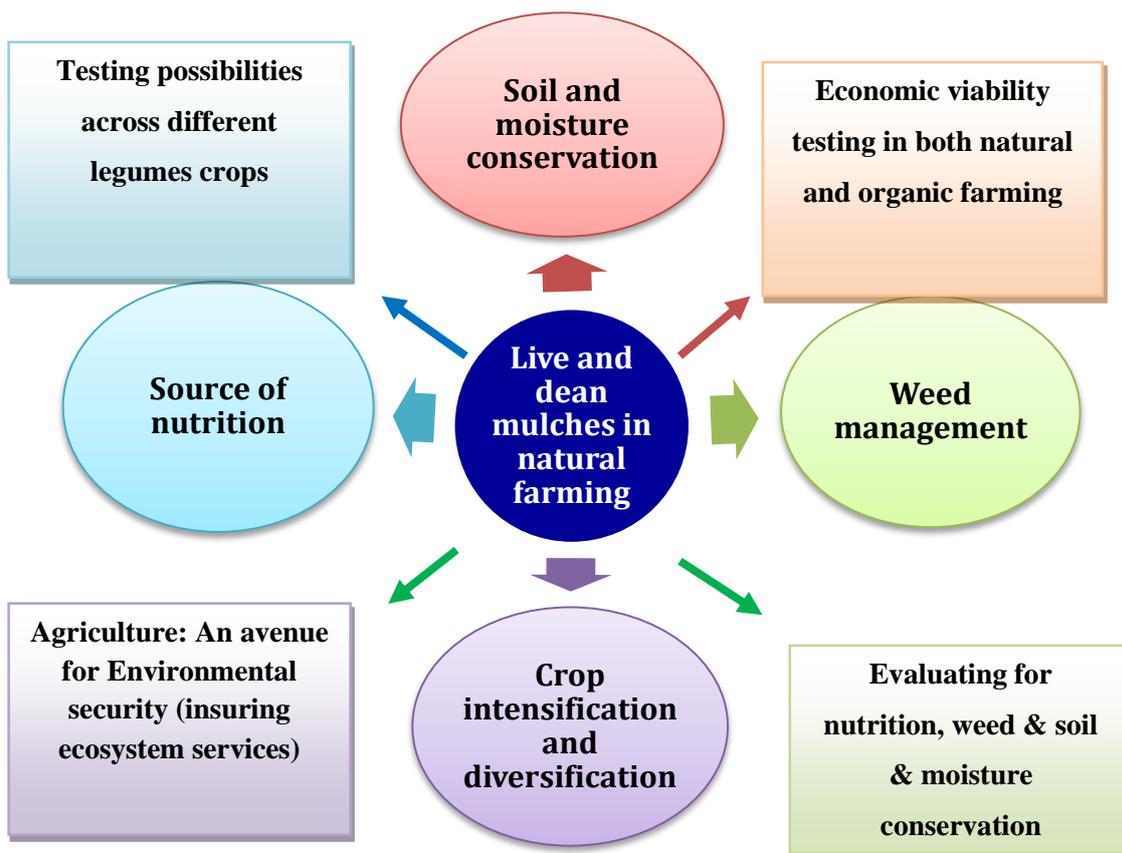
**Brown manuring – An overview:** The brown manuring (BM) is the co-culture of different leguminous crops with main crops and knock down of these BM crops with 2,4-D at the time of flowering in-situ. The use of 2,4-D is possible in cereal crops; while in other several crops such as pulses and oilseed crops such as mustard, cotton, pigeonpea, soybean, etc. it is not possible due to adverse effect on main crops. The BM is most commonly practiced in direct seeded rice with *Susbania* (*Susbania spacirosa*) as crop for BM (Maity and Mukherjee, 2011; seema et al., 2015). The range of BM crops can be further increased to several crops such as Dhaincha (*Sesbania aculata*), sunhemp (*Crotalaria juncea*), cowpea (*Vigna sinensis*), green gram (*Vigna radiate*) and cluster bean (*Symopsis tetragonaloba*). The crop nutrition and weed management are the major function of brown manuring crops highlighted with agrochemical based modern production system as major niche. At the same time, soil conservation, mulching effect and crop yield enhancement and economics over other methods of weed and nutrient management are the other positive effect for which brown manuring are being practiced. The brown manuring of *Sesbania* @ 25 kg ha<sup>-1</sup> + 2,4-D application @ 0.5 kg a.i. ha<sup>-1</sup> found superior and recorded highest weed control efficiency lowest total weed dry weight, highest grain yield and energy productivity and found comparable to two hand weeding in wet season rice (De et al., 2024). The combination of pre-plant herbicide (Butachlor/ Pertilachlor/ Pendimethalin/ Benthocarb) + brown manuring+ 2,4-D was found superior over combination of herbicide + hoeing (30 DAS)+2,4-D (as post-emergence). Among these combination, Butachlor + brown manuring+ 2,4-D was found best in terms of increasing grain and straw yield, nutrient use efficiency (N, P, K), net returns and B:C ratio (Maity and Mukherjee, 2011). As most of BM crops are legumes and legumes in crop rotation is important practices suggested in OF and NF as well, discussion of legumes and their role in cropping system/ production system will be essential.

**Legumes in different cropping system:** The legumes are known for both ecological and economic impact considering their soil restorative nature and higher market prices due to protein content in them (Jager et al., 2019). They are also distinguished agro-ecologically as most of them are well known to grow in rainfed agriculture. The short duration grain legumes (pulses) such as green gram, black gram, cowpea and non-pulses legumes such as sunhemp, cluster bean and *Sesbania* are well known for their important place in crop rotation and intensification/ diversification of cropping system (Vanlauwe et al., 2019). The capacity to stand in additive series of intercropping and cover the weather risk beside weed management impact makes them a best choice for intercropping in several *kharif* season crops. The legumes such as groundnut and soybean are being treated as main crops due to their potential impact on oilseed production in India and the world as a whole. The indices such as land use efficiency, multiple cropping index, minatory equivalent index, cropping intensity index used for calculation of land and biological productivity of cropping system were also found increased significantly with inclusion of legumes in cropping system. Tang et al (2020) found in their meta-analysis of 17 studies (selected over 3000 publications) that, legumes + cereal cropping system improve land use efficiency and phosphorus uptake indicating the role of legumes. The role of legume intercropping was also mentioned by Matusso et al. (2014) with their potential to increase productivity, profitability, water and radiation use efficiency, control of weed and pest and disease management. The multiple benefits of legumes such as reduced greenhouse gas emission, carbon sequestration, reduce fossil energy used in nitrogen fertilizer production (due to biological nitrogen fixation), potential in conservation agriculture as potential source of crop residue and other environmental and socioeconomic benefits were reported by Stagnari et al. (2017). Fan et al. (2020) reported that intercropping of maize + soybean increase economic yield by 536 and 761 kg ha<sup>-1</sup> for 50:50 and 60:40 % area occupied by maize and soybean, respectively. These intercroppings also reported to significantly increase the N, P and K uptake and utilization besides higher land equivalent ratio of 1.43 and 1.32, respectively. The suitability of legumes in organic arable crop production system due to its capacity to increase yield of cereal + legumes intercropping system, enhance cereal grain protein and weed control effect was reported by Bedoussac et al., (2014). Choudhary et al. (2017) reported that maize + soybean and maize + groundnut intercropping system increased land use efficiency, land equivalent coefficient, N and K uptake, soil moisture content and solar radiation interception. This indicates that legumes will be a potential crop option for OF and can be considered for evaluation with NF. Besides that, considering their narrow C:N ratio, rapid decomposition, high nitrogen content, short duration and capacity to increase microbial activities, legumes are considered as an option for fertility enhancement with green and brown manuring is being an important option.

**Legumes for live and dead mulching in natural farming:** The mulching is one important component of NF and is meant for water conservation, weed management and protecting soil from being eroded/ degraded. They are also acting as sources of nutrients and amendments if they are being organic in nature. The soil mulching is common in arable crop production involving shallow tillage during crop growing season to control weed. Besides that they break the continuity of soil capillary thereby reduce the losses of soil moisture. For orchard, stone mulching can be considered. These both soil and stone mulches are inorganic mulches suitable for natural farming. The possible sources of organic mulch in NF are use of crop residue and left over fodder from animal yard, bedding material from poultry houses, weed vegetation (before flowering) and brown manuring for mulch.

Besides that cultivation of fodder crops as break crop or off-season cultivation and growing of trees with rapid coppicing ability (*Gliricidia*, *subabul*, *casuarina*) will also help in providing biomass for mulching. The crop residues have multiple uses and other sources of organic matter are acting as fodder or their availability of not uniform or treated as ex-situ sources. Hence, identification of crops (specifically legumes) which can be grown with main crops for few days during which is it providing support to main crops through biological nitrogen fixation and uprooting them before reaching to flowering (or start competitive interaction) will be worthy. This will be gentle modification over brown manuring in which the use of 2, 4-D is done to kill the plants. This can be done by uprooting or cutting crops or application of high concentrated solution of common salt (NaCl) to kill the legumes planted in main crops. The crops such as *Sesbania* (*Sesbania spaciosa*), Dhaincha (*Sesbania aculata*), sunhemp (*Crotalaria juncea*), cowpea (*Vigna sinensis*), green gram (*Vigna radiate*), clusterbean (*Symopsis tetragonaloba*), gliricidia (*Gliricidia sepium*), neem (*Azadiracta indica*), Pogamia (*Pongamia glabra*), Gulmohar (*Delonix regia*) and *Peltophorum* (*Peltophorum ferrumgenum*) can be considered for this purpose.

As these crops provide mulching effect due to their biomass production during both live and dead they can be considered as important interventions to address the constraints of biomass availability for both mulch and organic sources of crop nutrition. As discussed earlier section about significance of brown manuring, these mulches also have significant contribution to crop nutrition and will be more beneficial than other form of mulches. Besides that, these legumes crops do not have much nutrient requirement (especially nitrogen) they can be grown with less nutrient addition or with nutrient added to meet the need of for main crop alone which further signifies their role. The legume rhizosphere is considered as rich in microbial population with high microbial activities, they are again a best component for NF as soil biological health is given more importance in NF. In a study conducted by Choudhary et al. (2022) involving combination of mulching (@ 10 t ha<sup>-1</sup>) with *Ghanjeevamrutha* + *jeevamrutha* reported to significantly increase soil organic carbon, soil available nitrogen, soil available phosphorus and soil available potassium over application of mulching (10 t ha<sup>-1</sup>) alone. Besides that soil bacteria, fungi and actinomycetes population as well as dehydrogenase activity was found significantly superior over other treatments. Application of mulching alone found superior control in all these parameter in both two years of study indicating role of mulching as well as complementary action of mulches with other bio-inputs in NF. In another study Xu et al. (2009) reported that use of winter wheat residue and intercropping of peanut as cover are found a valid option for weed management in natural farming (Figure 1). This will be different from intercropping of legumes in the sense that, in intercropping input application decisions are as per main crop; while due consideration is given for intercrop as well while taking decision on input application another management practices. In live and dead mulching practice no any scope will be given for legumes grown as intercrop in decision on input application and their management. Besides that it is also not same as that of additive series of intercropping where 100 % plant population of sole crop is maintained. In live and dead mulching the plant population is much more that sole crop plant population and seed rate recommendation of brown manuring or green manure followed for such live and dead mulching. Therefore finding the similarities of other form of production practices and comparing them with NF will be an important attempt to initiate the NF with live and dead mulching of legumes as potential option.



**Figure 1.** Overview of live and dead mulching in natural farming

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