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Review Paper

Mulching in Natural Farming through Incorporating of Legumes crops

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Abstract

The natural farming is public initiated movement towards self-reliant and sustainable agricultural production system with weight age to crops, trees and animals. Hence, the crop/ plant which are in favour of these three components will be well adopted in NF. The mulching is one important component in NF with wider impact on soil health, plant/ crop productivity and water management. Incorporating crops which provide mulching effect beside other beneficial effect such as legumes is important in NF. The cultivation of legumes has wider potential options to be investigated for their potential in NF. This article overview the potential options for incorporating the legumes in NF with their consideration, pros and cons. The legumes crops such as cowpea, green gram, cluster bean, sunhemp, delonix, sesbania and gliricidia are well known for their multiple and significant positive have effects in crop production which more highlighted as green and brown manuring. These crops will serve as mulching in NF with different options such as inter-cropping, inter-planting, economic crops with residue used as mulch material, green manuring, brown manuring, and multipurpose legumes tree species as source of vegetation for mulching. These legume crops are also compatible with other component such as acting as animal feed, valuable economic crop and source of protein to animal and human being. Therefore, it will be essential to further improve and investigate legumes for mulching and other potential benefits in NF.

Keywords: Green manuring, brown manuring, multipurpose tree species, soil health.

Introduction

The natural farming (NF) is one of recently emphasized production system which was earlier a component of organic farming (OF) with emphasis on soil health management, soil microbial functional biodiversity, in-situ nature of input use and weight age to crops, trees and animals. The NF is defined by *NITI Ayog*as "chemical free traditional farming system which considered as an agro-ecology based diversified farming system which integrates crops, trees and livestock with functional biodiversity". Being a public based intervention with pioneer worker across the India, its adoption is not a matter of scientific and extension institutional efforts; while its further spread and investigation need to scientific approach which is being imparted by different institutions across the India at present[1-4]. Even through the term natural farming is not new and given by Masanobu Fukuoka long back in 1975. (One straw revolution), the variable components added to this original concept across the agro-climatic zone and with advance of time make it a new and significant production system with its components being most highlighted (Figure-1). The natural farming at present is one of the major agricultural technologies being investigated to understand the scientific basis of practice and input being adopted in NF; while preparation and enrichment of inputs used in NF is of most interest of scientific communities[5]. It will be valid and needful to investigate the practices in NF to determine the role, usefulness and contribution of soil, plant and water in agro-ecosystem. In this regards, the five major components of natural faming viz. *Beejamrutha*, *Jeevamrutha*, *Wapsha* condition, mulching (*Achadana*) and plant protection being highlighted most for investigation. Besides that, being complex due to involvement of three different components and taking in to consideration of large number of indigenous technics, it will be worthy to investigate these components for their further enrichment and modulation needed for NF and may be for incorporation in other production systems.

Among all components, mulching is one such component of NF which has multiple considerations and also suits as well as adopted in conventional and organic production system[6,7]. The mulching is being advocated for its variety of beneficial effect in crop production as well as on natural resources[8]. It is also one of the important components of soil and moisture conservation practices in dryland areas[9]. The mulching is investigated for its role in weed management[10], soil moisture conservation, moderating soil fertility as well as significant impact on crop production[11]. It is also an important component of protected cultivation where it is utilized for weed management and moisture conservation[12]. Aside from this regular concept, mulching in NF is being conditioned by organic, in-situ and both live and/ or dead organic materials. At the same time, there is no much specification given about the material being used, quantity, frequency, potential impact on present crop and residual effect of mulching as well as their contribution to

different aspect of crop production system. Therefore it will be worthy to consider mulching practices for further discussion.

Among the different options for mulching in NF, the legumes are of significant importance considering their role in soil, plant and water management. The legumes are groups of crops literally meaning 'group of pods' or 'collection of pods' with protein as major reserve in their seeds. The investigating legumes for their soil restorative nature[13] and as important component of crop rotation and intercropping/ mixed cropping[14] are reported along with its potential commercial crops values. Besides that, the legumes are also known for green[15] and brown manuring[16] with their significant role in soil improvement, crop nutrition and crop yield improvement[17]. Considering its positive impact in crop production, it will be also an important component in NF with potential to provide and act as mulching as additional role over other roles. The study of legumes as mulch crops will generate additional information as well as make it possible to provide crop nutrition, animal feed and energy for NF. This will justify the selection of legumes as potential options for mulching in NF (Figure-2). The objective of this article is to highlight different aspects of legumes by which it can be considered as potential option for mulching in NF.

Comparison of natural farming with different parallel concept in agriculture

The adoption of natural farming at present is initiated with growing trend of differentiating NF with different concepts and production system with more comparison with organic farming[18]. The definition, approach and focus involving in-situ production and use of inputs are being essential to separate NF from organic farming[19] (Table-1). The NF was earlier a part of organic farming and now being distinct with different concepts such as *Homa* harming and biodynamic farming[20]. Besides that certification, standard, calibration and measurement also need to be highlighted to differentiate the NF from organic farming. These all specifications are well established for organic farming; while for natural farming these are needs to be established. Natural farming is distinguished from farming system concept with different aspects such as types of input used, components and certification requirement. For farming system certification is not needed with freedom to use both ex-situ and in-situ inputs; while in natural farming certification will be developed and there should be use of only in-situ inputs in production system. With regards to conservation agriculture, herbicide use, principles and mecahnization are major point of disagreement with natural farming. In conservation agriculture, both herbicide use and mechanization is emphasized in order to reduce the intensity of tillage system; while in natural farming both are not allowed. This growing trend of distinguishing natural farming from organic farming and other concept helps in establishing the concept of natural farming; while finding the similarities of other concept and production system with natural farming will be worthy in order to increase the adaptation rate of natural farming (Table-2). The organic farming is similar with natural farming with respect to role of un-decomposed manure, crop rotation, standard establishment, use of ITKs and plant protection to some extent. The natural farming is having similarities with farming system due to involvement of animal and tree component as that of farming system. Besides that, in-situ recycling of by-products as well as mimicry of natural ecosystem was present both in natural farming and farming system approach. The emphasis on soil health, least disturbances to soil and crop rotation is given in both conservation agriculture and natural farming. These three points explain the environmental friendliness of both production systems. In the definition of natural farming, it is mentioned that natural farming follows the agro ecology. The components of natural farming are more or less same as that of principles and components of agro-ecology[21-23] (Table-2). The mulching is also commonly reported in conservation agriculture, organic farming and farming system approach; while in natural farming it is treated as important component; hence considering the role of mulching is all types of environmentally responsible farming and its significance, it will be worthy to overview it is different aspects for natural farming. The tangible benefits of mulching include soil fertility enhancement, weed management, biomass production, increase soil water availability and act as cultural method of insect-pest and disease management. These benefits have economical significance in crop production in natural farming. Besides that the non-tangible benefits such as moderation effect on soil temperature, soil reaction and soil and moisture conservation can be also achieve with mulching.

Intercropping and inter-planting of legumes mulch crop in NF

The potential of legumes as live mulching through intercropping/ mixed cropping is higher due its capacity to act as economic crop producing yield with providing mulching effect[14]. After harvesting of these crops, their crop residue can be further used as mulch material provided that they are not diverted for animal feed. The legumes crops in intercropping/mixed cropping have complementary and synergistic interactions with main crops thereby increase the resource use efficiency without any degradation. The microbes – plant interaction are tilted towards the beneficial side and further intensify during crop cultivation which is in favour of natural farming principles. Besides intercropping, the inter-planting is another concept in which annuals herbs are being sown in perennial vegetation (orchards) which are generally planted at wider spacing. As the natural farming have tree component, there is potential to incorporation legumes for inter-planting. The inter-planting is beneficial in terms of dual mulching effect which includes live mulching when crops are growing and dean organic mulching in tree basins through use of residue after harvesting of legumes. The inter-planting is very effective in terms of weed management in orchards as well as economic use of inter-row/ plant space. The additional investment in terms of seed and sowing as well as nutrient

application is required in order to make legumes competitive with weeds and produce required biomass for acting as mulch. There is potential to test effect of live mulching of legumes on performance of orchards as well and cost effectiveness of such live mulching on management of orchards in natural farming need to be further investigated.

Green and brown manuring for mulching in natural farming

The in-situ cultivation green manuring crops followed by their retention on soil surface rather than incorporation in soil is another option for mulching with legumes in natural farming. In this case, the crops should be grown for 45-60 days before main crop cultivation and then the biomass is used as mulch by cutting/ uprooting above ground growth of legume crops. This can be possible in area with pre-monsoon shower such as North East Hill region or where monsoon onset is early with window of 30-45 days between monsoon onset and sowing time of *kharif* season crops. The additional investment for P fertilization, seed and sowing and field preparation to some extent is required for their cultivation; while the biomass production will be huge, which can be also treated as source of nutrition to main crops. The potential legumes for this can be sesbania (*Sesbania spaciosa*), Dhaincha (*Sesbania aculata*), sunhemp (*Crotalaria juncea*), cowpea (*Vigna sinensis*), green gram (*Vigna radiata*) and cluster bean (*Symopsis tetragonaloba*). There is another option which do not require cultivated field and treated as ex-situ. This includes cultivation or green manuring (mostly perennial) crops on uncultivated area, field bunds and along the farm roads. The green leaves and young twigs were cut and used as mulch material. These plants need to have coppicing ability to grow further after cutting of young portion every year. The potential crops such ex-situ manuring are gliricidia (*Gliricidia sepium*), neem (*Azadiracta indica*), Pogamia (*Pongamia glabra*), Gulmohar (*Delonix regia*) and Peltophorum (*Peltophorum ferrum genum*). The multiple uses (feed to animals), wide range of crops and soil health improvement are the point of consideration which match with the component and principles of natural farming. Besides that there are some other plants which are treated as weeds and can be considered for utilization ad mulch material production. These plants are cassia (*Cassia fistula*), calotrophis (*Calotrophis gigantea*), Parthenium (*Parthenium hystorophorus*), trianthema (*Trianthema portulacastrum*) and water hyacinth (*Eichhornia crassipea*); while their use of biomass is attached with several considerations and constraints such as enriching the weed seed bank and use them before flowering and seed settings.

The brown manuring concept is popular in direct seeded rice which involve co-culture of Sesbania (or any other green manuring crops) for first 30-45 days followed by knock down it with the help of herbicide (mostly 2,4-D). This practice can be modified to some extent by replacing herbicide with uprooting of *Sesbania* and spreading in inter-row space which act as much. As these crops are legumes, they will produce canopy in between main crop rows and reduce the space and other resources available for weeds for first few days (40-45 days) there by act as live mulch; while after uprooting the biomass spread in between inter-row will act as dead much thereby protecting main crop throughout growing duration. This can be done on both arable crops (seasonal/ annuals) or perennial crops (orchards) provided that cost in uprooting or cutting and seed and sowing will be additional. This additional cost will be worthy as cost of weed management in absence of such mulching will be same or some time much more cost than seed and sowing cost brown manuring. For this the range of crops is same as that of green manuring. These crops are also treated as multipurpose crops such as grain crops, fodder crops and green vegetable crops. These all functions are matching with the requirement of natural farming and hence have huge potential to be implemented in natural farming. Besides that there is lack of information about quantification of potential of these crops in natural farming for their effect on soil, plant and water which need to be further investigated.

The nutrient content in such legumes used for green and brown manuring is higher which make them an important component of crop nutrition in natural farming for example Sesbaniaaculata contains 3.50% N and 0.60% P_2O_5 and 1.40% K_2O[24] (Table-3). Besides that the biomass production potential of such crops varies from 23t/ha *Sesbania aculata* to 30 t/ha for *Crotolaria juncea* accumulated in 60 days duration which further signifies their claim of acting as mulch crops in natural farming (Table-4). The cluster bean is being reported to produce low biomass (3.2t/ha).The performance of these legumes crops are subjective to agro-climatic condition as well as input and management practices which need to be taken in to account while selecting the legume crop for mulching. The cost on nutrient management and seed and sowing specification is one of the important considerations that is involved in successful cultivation of these legumes as mulch crop in natural farming. The use of untreated rocks and minerals such as rock phosphate, calcium silicate, etc. should be also considered for fertilizing these crops in natural farming[25].

Use of legume tree species for ex-situ production of mulching materials

The legume tree species is another potential option to incorporate legumes in natural farming as much crops. This is due to fact that, tree is important component of NF and such legumes trees are complementary to crops and animal component of NF. These trees are known to have and should have coppicing ability and quick growth. They are also an important part of agroforestry and cultivated as energy plantation and protein bank in different agroforestry system[26,27]. Being rich in protein and produce huge biomass with wood production, such tree species are also referred as protein bank or energy plantation (besides their multipurpose tree species uses). The potential tree species are *Leucaena leucocephala*, *Acacia nilotica*, *Calliandra calothyrsus*, *Faidherbia albida*, gliricidia

(*Gliricidia sepium*), etc. Such trees are not suitable to be cultivated as main crops and cannot able replace main arable crops even though they have multiple uses. As natural farming is evolving concept, there is need to investigate the suitability and productive potential of different tree species for natural farming.

Table-1: Differentiating natural farming with other production systems[28].

Natural farming versus 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, GM 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	*Homa* farming, Rishi farming *Panchagavya* farming, Zero budget natural farming and *Agnihotra* 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
Natural farming versus farming system		
Particular	Natural farming	Farming system
Components involved	Three: Crop Tree and Animal	More and multiple components involved with diverse nature.
Inputs used	Organic	Both organic and inorganic with major emphasis on organics
Disturbances to natural resources	Least	More than natural farming
Input sources	In-situ	Both in-situ and ex-situ with major emphasis on in-situ.
Processing of bio-inputs	More processing with emphasis on enriching inputs for nutrients and microbial activities for soil health management.	Less processing in-situ with major emphasise on efficient recycling
Plant protection	Bio-input production and use in-situ	Bio-input (both in-situ and ex-site) as well as purchased inputs
Scope	Intensification with indigenous technology and crops/ animal bio-diversity	Intensification with all types of inputs and components used in system (both OF, NF and Conv. Farming).
Commercialization of input-output	Expected and needed in future	No any such interventions needed
User interface of the products	Expected to be well defined due to distinct quality	No any such specific use interface
Mulching	Important Component	Not emphasized as that of NF
Certification	Needed	No such procedure
Natural farming versus conservation agriculture		

Particular	Natural farming	Conservation Agriculture
Herbicide use	Not allowed	Essential component
Inputs	Should be organic and in-situ	No any boundation about source and nature (organic and inorganic)
Crops/ species / varieties	Traditional/ local/ landraces	Improved varieties and hybrids are mostly preferred
Purpose	Crop production with natural ecosystems	Soil and moisture conservation/ reducing carbon footprint
Principles	Addition to three principles with agro-ecology, diversification and organic farming as major component.	Three principles
Mechanization	Optional and animal power is must.	Must
Niche	Area with indigenous types of cultivations, rich agricultural heritage with pioneer workers and hilly region,.	Highly intensive and productive cropping system
Approach	Combination of crops, tree and animal.	Crop or cropping system based approach
Animal component involvement	Essential	Not needed
Mulching	Mulching as an important component with different options for it along with crop residue	Crop residue retention (min. 30 %)
Certification	Needed	No any such procedure

Table-2: Similarities of natural farming with other production systems.

Natural farming and organic farming		
Particular	Natural farming (NF)	Organic farming (OF)
Role of non-decomposed Manures	Green and brown manuring	Green and brown manuring
Crop rotation	Legumes and grasses	Same as that of NF
Standard establishment and certification of products	Needed	Needed
User interface (consumer targeted)	Possibility to reduce Bio-colonialism to some extent.	Bio-colonialism is more common and expected to a great extent
Use of indigenous technical knowledge	More required	More required
Use local/ traditional crops/ species/ varieties	Emphasized in both OF and NF.	Emphasized in both OF and NF.
Plant protection	Emphasis on preventive, cultural and mechanical measures followed by use of biological agents/ products.	Emphasis on preventive, cultural and mechanical measures followed by use of biological agents/ products.
Natural farming and farming system		
Particular	Natural farming (NF)	Farming system (FS)
Interaction and their management	More or less same as that of FS	Harvesting complementary and synergistic interactions among the components and avoid competitive interaction

Emphasis	More of in-situ and welfare of soil, plant and water.	More of in-situ and welfare of farm family first.
In-site cycling of by-products	Emphasized with less options than FS	Emphasized with multiple options
Resilience and sustainability	More	More
Mimicry of natural ecosystem	Present with least disturbance with natural resources	Present with less disturbance with natural resources
NRM approach	Conservation with productive outcome from them	Conservation with productive outcome From them
Natural farming and conservation agriculture		
Particular	Natural farming (NF)	Conservation agriculture (CA)
Soil disturbance	Least	Reduced to great extent through minimum and zero tillage
Mulching	Essential component	Achieved through crop residue retention
Crop rotation	Emphasized with legumes and grasses	Important principle of CA
Soil health	Significantly improved	Expected to be superior over conventional tillage practices
Environmental friendliness	Conservation diversification and natural ways of crop production	Superior over conventional practices due to more carbon sequestration

Table-3: Nutrient content in green manuring crops[24].

Crop	Major purpose for cultivation	% nutrient content in dry matter		
		N	P_2O_5	K_2O
Dhaincha (*Sesbania aculata*)	Green and brown manuring crop; as seed crop	3.50	0.60	1.20
Sunhemp (*Crotolaria juncea*)	Green and brown manuring crop; as fibre crop.	2.30	0.50	1.80
Sesbania (Sesbania spaciosa)	Green and brown manuring crop; as seed crop.	2.71	0.53	2.21
Gliricidia (*Gliricidia sepium*)	Green leaf manuring; fodder and borer crops.	2.76	0.28	4.60

Table-4: Biomass production potential and nitrogen contribution of green manuring crops[24].

Crop	Purpose of study	Age (days)	Dry matter accumulation (t/ha)	Nitrogen accumulated (kg/ha)
Sunhemp (*Crotolaria Juncea*)	Green and brown manuring crop; as fibre crop.	60	30.6	134
Cowpea (*Vigna sinensis*)	Grain crop, vegetable crop, fodder crop.	60	23.2	74
Cluster bean (*Symopsis tetragonaloba*)	Vegetable crops; commercial crops	50	3.2	91
Dhaincha (*Sesbania aculata*)	Green and brown manuring crop; as seed crop	60	23.2	133

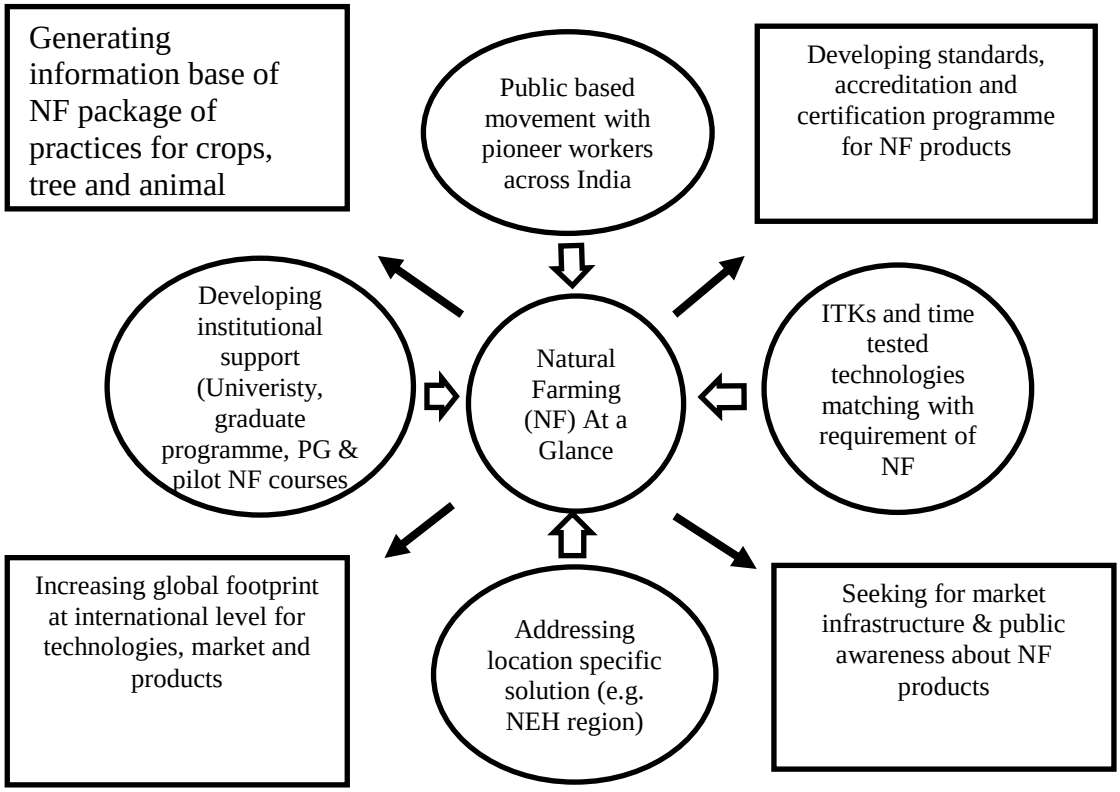

Figure-1: Natural farming at a glance.

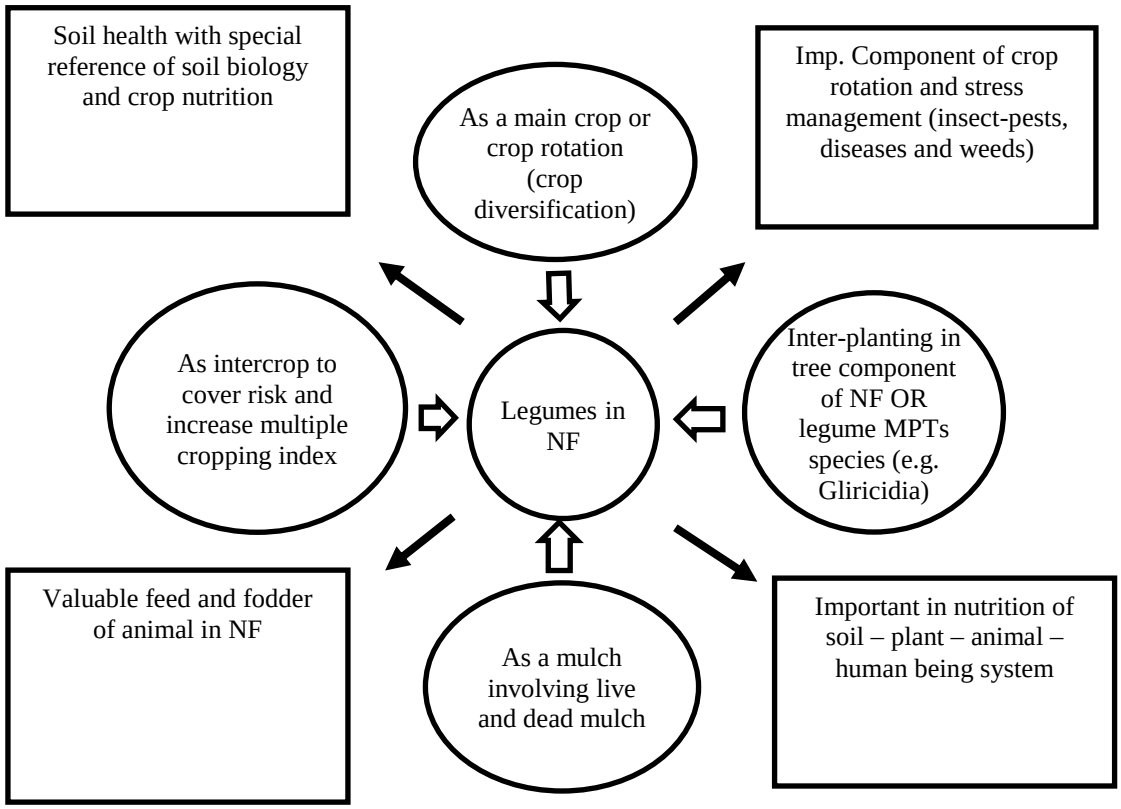

Figure-2: Role of legumes in natural farming.

Conclusion

The mulching is an important component of natural farming having multiple positive effects in short and long duration; hence investigating potential options for mulching is essential. Besides that, the legumes crops have significant and well proven role in soil, plant and water management which is important principle of natural farming; hence considering legumes crops for generating mulches in natural farming will be worthy. Due to involvement of large number of crops with diversity in growth habit, there is huge potential to be investigated from different legume crops to be act as mulches in natural farming.

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