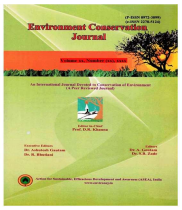
Environment Conservation Journal 23 (1&2): 99-106, 2022

Journal homepage: https://www.environcj.in/

Environment Conservation Journal

ISSN 0972-3099 (Print) 2278-5124 (Online)



Subhash palekar natural farming - scope, efficacy and critics

Purushottam Dev
Department of Soil Science, College of Agriculture, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur (H.P.), India.
S. S. Paliyal
Department of Soil Science, College of Agriculture, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur (H.P.), India.
Navjot Rana ✉
Department of Agronomy, College of Agriculture, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur (H.P.), India.

ARTICLE INFO

Received : 25 September 2021
Revised : 12 December 2021
Accepted : 21 December 2021

Published online: 31 January 2022

Key Words:
Cow dung
Green revolution
Natural farming
Organic farming
Productivity growth

ABSTRACT

By 2050, India is expected to surpass China as the world's most populated country, with a population of almost 1.7 billion people. To feed this exponentially increasing population, the country must pursue a policy of vertical productivity growth, as the possibilities for additional horizontal expansion of cultivated land are rapidly diminishing. Furthermore, continual cropping depletes soil nutrient resources, necessitating the replenishment of soils with critical major and minor plant nutrients. The country cannot compromise with nutritional supply in order to end "Silent Hunger" and the immoral perpetuation of high concentrations of increasing number of malnourished children and anaemic moms. While the country is intending to restructure its agricultural production system, including R&D, to meet the needs of rising problems, the 2018-19 economic survey established a strong case for the widespread adoption of 'Zero Budget Natural Farming' (ZBNF) to double farmers' revenue. As a result, crop productivity will remain low, and farmers will not be able to earn enough to double their income and get out of debt with this level of output. Also at the country level, we will not be able to meet the expanding populations food and nutritional demands and hence will fail to meet the sustainable goals of "Zero Hunger and Poverty Elimination" by 2030. Thus, with zero budget natural farming practices we can feed to the India and world, our emphasis is too elaborate all aspects.

Introduction

India is the second largest country in terms of demography and feeding the population of 130 crores is a humongous task. Sustainable development and food security are the wheels on which Indian agriculture runs. However, the term food security replaced with nutritional security is more appropriate. Green revolution has certainly made us self-dependent in terms of food security but its aftermath was devastating. The input intensive agriculture lured farmers of taking non-institutional loans but the low productivity, monsoon dependence, low minimum support price, market upsets trapped farmers in infinite loop of debts. According to the National Bank for Agriculture and Rural Development's (NABARD), 2018 financial inclusion survey, 52.5 percent of all agricultural households in India were in debt. NABARD gave the country a gift on August 16 when it released the results of its All-India Rural Financial Inclusion Survey (NAFIS), which revealed that 87 percent of families were small and marginal farmers. NAFIS estimates that in the agriculture year 2015-16, according to household-level statistics, the average Indian agricultural household earned Rs. 8931 per month. Annual changes in agricultural production have been connected to weather, minimum support prices, demand-supply gaps, and natural disasters. India has certainly grown from its days of hunger to exporting food commodities of worth about 11.72 billion US dollars (DGCIS, 2019-20), but after the green revolution India has heavily depended on import of fertilizers pesticide and several other chemicals for conventional farming worth 2,098.61

Corresponding author E-mail: *Navjotrana7@gmail.com*
https://doi.org/10.36953/ECJ.021896-2158

million US Dollars in year 2014-15 (Department of fertilizers, 2014-15). The injudicious use of chemicals in soil has damaged the fertility by degrading its physical, chemical and biological aspects damaging native soil flora, loss in population of honeybees and several other agriculturally beneficial insects, polluting water and atmosphere compelled the policy makers and scientists to steer their strategies towards organic farming.

The other problems include shift in cropping system, depletion in groundwater, loss of nutrients, loss of organic carbon and pesticide residual effects. The subsidies on fertilizer also cost a staggering amount of 79,996 crores during year 2019-20 according to the budget estimate (FAI). India aims to double the farmers income by 2022, but there are several roadblocks ahead in achieving this goal. There are several problems which can be mitigated through organic farming system. However, organic farming has 5-12% less production than conventional farming in low water stress areas and 7-15% less production in water stress areas. Organic farming has shown promising results in terms of sustaining soil health but lags behind yield and productivity in comparison to conventional farming. In order to feed the ever-growing population, the agrarian crisis must be resolved by combining strong government policies with funding and improved agricultural practises. The concept of natural farming originated from Japan by a naturalist and philosopher named Masanobu Fukuoka (1913–2008).

Principally it minimises the human interaction while it gives nature to do its own so it is also called do nothing farming.

According to FAO, 2017 India still has a quarter of the world's hungry population and about 190 million people who are malnourished. Poverty is currently estimated to affect approximately 30% of the population. In the period from July 2012 to June 2013, farm households earned INR 77,888 or INR 6491 per month (NSSO, 2016). Even though, being a leading producer in many agricultural commodities, India lags behind many developing countries in terms of per capita income and living standard of farmers. These huge gaps between the earning of small and large farmers can be filled by Palekar's natural farming which require low input and tailored fitted for small and marginal farming. In India, Subhas Palekar introduced the idea of zero budget natural farming which include a desi cow (*Bos indicus*) as the focal point for input. Cow urine, dung, butter milk, jaggery, pulse flour and other several homemade products serve as input. The basic principles of natural farming are of intercropping, agro-forestry, microbial inoculation and increasing the activity of native soil biota. The inputs for natural farming are homemade, low cost and has no negative ecological impact.

What is Subhash Palekar Natural Farming (SPNF)

It is naturistic way of farming given by Subhas Palekar for the farming of marginal and small farmers using desi cow's products. There are basically four wheels of natural farming named- 1) *Beejamrit* (Nectar for seeds), 2) *Jeevamrit* (Nectar of microbes), 3) *Acchadana* (mulching) and 4) *Whapasa* (Soil moisture). According to Palekar for 30 acres only one desi cow is required and in absence of cow, buffalo can be used but he suggest that native cow breed have greater microbes population compared to exotic counter parts and desi cow is more adaptable to Indian conditions, less disease susceptibility and it is easily manageable by the resource poor farmers. It is extreme form of LEISA (low external input sustainable agriculture) that use the symbiotic relationship between cow output as farm input. Cow dung is also said to attract earthworms that are currently missing from our farms. It is a grass root level movement started by Padmashri Subash Palekar (2006) in mid 1990s which spread through Karnataka, Andhra Pradesh, Punjab, Himachal Pradesh and Kerala is planning to adopt it. Central government has also talked in length and breadth about it but there was no budget allocation in the year 2019-20. India has about 82% small and marginal farmers but till date there are only few viable options for small scale farmers thus, there is huge gap in earning of large and small-scale farmer. Natural farming system should be seen as a solution to small farmers. Palekar was appointed as advisor to Karnataka state government. Andhra Pradesh has a very ambitious plan regarding adoption of SPNF/ZBNF, according to Galab *et al.,* 2019 6 million farmers are ready to adopt zero budget natural farming by 2024.

The main contribution of natural farming is making small farmer financially independent. It promotes neo-Gandhian virtues such as self-sufficiency and autonomy. (Khadse and Rosset, 2019). It involves a variety of agro-ecological principles, such as diversification, nutrient recycling and promoting positive biotic interactions, among others, to improve soil fertility (Palekar 2006).

A survey was conducted on ZBNF, and it was noted that among 97 farmers and their households who adopt ZBNF, debt was reduced up to 30 %, environmental reasons by 42 % and also decrease in cost of cultivation by 38 % and apart from all these benefits **to** their family health was increased up to 54 % as compare to farmers who adopt other farming practices (Khadse *et al.,* 2018).

From the survey it was revealed that adoption was not only for food security or for sustaining development but it was overall development of a farmer. Finance Minister Nirmala Sitharaman had mentioned in her budget speech the need to "return to basics" and "replicate this unique concept (that) will aid in doubling our farmers income". Zero budget natural farming practices major advantages are- it is fully chemical free, sustaining soil and environmental health, almost zero cost of cultivation, use of traditional seed (climate resilient, low input intensive, preservation of traditional seeds), risk reduction by crop rotation, easier to adopt, preservation and entanglements of desi cow breeds. Palekar has done workshops throughout India and spreading his innovative idea.

Beejamrit/ Beejamruth

It is a fermented cow-based product used for protecting seeds from soil and seed borne disease in their early establishment. It is not a nutrient source but microbial load and growth hormones. It is a concoction made from water (20 litre), cow dung (5 kg), cow urine (5 litre), lime and a handful of soil. The seed or seedling are dipped in *Beejamrit* and then planted. Various experiments have been conducted throughout India to find the efficiency of *Beejamrit* and *Jeevamrit* in various agro-ecological regions of India. In organic solutions, Sujana *et al.* (2019) discovered that the *Jeevamrit* treatment had considerably higher growth attributes and quality parameters of chilli fruits than the *Beejamrit* + *Jeevamrit* + *Amrutpani* treatment, with the exception of fruit length. According to Jandaik *et al.* (2015) all three fungal pathogens (*Ralstonia stolonifer, Sclerotium rolfsii* and *Fusarium oxysporum*) growth was maximum with the application of cow urine @ 15 % concentration. In ancient Indian literatures it was well documented that cow and its product have always a special place. According to Shubha *et al.* (2014), microbial population was increased when seeds was treated with *Panchgavya* and *Beejamrit*.

An experiment in Nanded (Maharashtra) showed that the *Jeevamrit,* FYM and *Beejamrit* increases the micro flora population of soil and yield suggesting thereby a positive correlation between fungal population and yield of Arhar (*Cajanus cajan)* in organic field compared to inorganic field (Shaikh and Gachande, 2015). A trial in Dharwad (Karnataka) stated that Bacteria isolated from *Beejamrit* increases N_2-fixation, inocitol acetic acid, gibberalic acid production and P-solubilization in addition to suppression of *Sclerotium*. However, not every experiment was in favour of *Beejamrutha* as other liquid organic formulations like *Panchgavya*, vermiwash were far better in terms of chemical analysis and growth and yield (Chadha *et al.,* 2012). They also discovered that Beejamrit was the most successful seed treatment, with 92 percent seed germination of pea seeds compared to 56 percent in the control treatment. It acts as a potent antibacterial and antifungal solution. Chandrakala, (2008) found out that seed weight of chilli was increased over control treatments with the application of *Beejamrut* + *Jeevamrit* + *Panchagavya*.

Jeevamrit/ Jeevamruta

Jeevamrit is a fermented microbial culture which acts as a fertilizer substitute made from water (200 litre), cow dung (10 kg), cow urine (5-10 litre), pulse flour (2 kg), jaggary (2 kg) and handful of soil from the farm. To ferment and to multiply aerobic and anaerobic bacteria 48 hours are given to mixture. It is believed that jaggery acts as a nutrient source for native soil microbes. Very high amount of microbial load was found under *jeevamrit* which helps in increasing soil bio mass even if we supply it at very lesser rate which helps in increasing soil health. *Jeevamrit* comparison with various other organics, Chongre *et al.* (2019) in Mohanpur (West Bengal) inferred that for better

organic package for gram, FYM @ 12 kg N equivalent at land preparation and Panchgavya @ 8 kg N equivalent (twice at 30 DAS and 45 DAS by irrigation water) may be advised. It is often said that it promotes immense biological activity. According to Palekar, to make system self-sustaining *Jeevamrit* is given only first three years. Lahariya *et al.* (2013) recorded significantly highest yield of soybean grain (16.70 q/ha) and straw (30.27 q/ha) with application of 100% recommended dose of nitrogen through vermicompost +*Jeevamrit* which was statistically at par with that of 100% RDN through vermicompost, whereas lowest yield was obtained in control and *Jeevamrit* alone. However, the minimum bulk density was found with application of 100% RDN through vermicompost + *jeevamrut*. According to Palekar (2005) all the nutrients that are required for the growth and development of crops are already presented in the soil thus no external input is required, we have to unlocked the existing nutrients and make bioavailable via *Jeevamrit*. Later it was called *Annapurna*.

With the application of *Beejamrit*, *Jeevamrit* and *Panchagavya* increase in yield of soybean by 25 to 35 % was reported by Shwetha and Babalad (2008). In general, it is not a substitute for fertilizer but it acts as a catalytic agent that promotes microbes and biological activities. In another experiment in Ludhiana (Pb), Aulakh *et al.* (2018) reported that crop productivity was not influenced with the application of *Jeevamrit* on the other hand soil microbial population was increased. *Jeevamrit* is also said to increase earthworm count that increases the aeration and water holding capacity and thus root surface area that increases the nutrient absorption. Lahariya *et al.* (2013) recorded the minimum bulk density of soil and highest hydraulic conductivity (HC), mean weight diameter (MWD) and available water capacity (AWC) with application of 100% RDN through vermicompost + *Jeevamrit*, might be due to presence of organic material.

Acchadana (mulch)

By managing soil temperature, maintaining soil moisture and lowering soil evaporation, mulching is an effective means of manipulating the crop-growing environment to boost crop productivity and quality (Chakraborty *et al.,* 2008). Three types of mulches which was suggested according to Palekar- i) Soil mulch- It protect the top soil during cultivation. He also suggested to avoid deep tillage, ii) Straw mulch- The previously grown crops residues or biomass from nearby trees or shrubs are used as a mulching and iii) Live mulch- It is necessary to grow monocot and dicot crops in the same field to get all the essential nutrients.

One of the key benefits of mulch is that it conserves soil moisture (Mulumba and Lal, 2008). Mulching enhanced soybean seed yields, according to Sekhon *et al.* (2005) in addition they said that it also raised plant biomass and nodule mass. All of the growth parameters were also improved. Despite these benefits, farmers have not taken to mulching since crop response varies depending on the season. According to Jordan *et al.* (2010), increasing mulching rates increased soil physical qualities. Under a mulching rate of 6 Mg ha-1year-1, there was a reduction in runoff generation and soil losses to bare soil.

Plastic mulching is considered as a better option for disease control as it leaves no chemical residue. Jalota *et al.* (2007) review shows that improvement was found in yield of crops with the use of straw mulching in Punjab. This practice also saved irrigation water and fertilizer nitrogen. The benefits of mulching are more in summer/ *kharif* season and on soils having low water retentivity. Chakraborty *et al.* (2010) burning of wheat and rice straw in the Indo-Gangetic plains is also causing one of the major causes of air pollution in northern Indian states. Central and state governments are also giving incentives to the farmers for not burning stubble and straw but it doesn't seem to be working at all. Mulching found to be effective in improving 25 % efficiency of crop water use and reduction of 3–11% water. Mulumba and Lal (2008) found that increasing mulch rates increased available water capacity up to 35%, total porosity up to 46% and soil moisture retention at low suctions up to 70%.

Legume intercropping advantages

Intercropping refers to planting two or more crops on the same field at the same time (Sangakkara *et al.,* 2003; Belel *et al.,* 2014). Baby corn equivalent yield and land use efficiency were higher in intercropping systems (47.2 percent), land use efficiency (15.3 percent) and monetary advantages, notably in 2:2 row ratios baby corn +

pea and baby corn + chickpea appeared to be the best intercropping systems in terms of yield benefits and economic returns. There are plenty of documents that praise the idea of intercropping both theoretically and practically that includes better yield, better use of environment resources, reduction of insect- pest and weed damage and improved soil fertility. Among different intercropping systems studied, According to Swain *et al.* (2012), the mango + guava + cowpea system increased soil physical and chemical properties. It may be suggested that inter-cropping breaks the chain of infection/events and it is also known that mono-cropping generally make the soil sick. It is generally said that inter-cropping increases dry mass production, reduced nitrogen application, crop diversity, better land utilization than sole cropping system according to Gitari *et al.* (2018). It is also generally seen that in intercropping there should be companion effect between major crop and inter-crop otherwise it may have negative effect on yield and other growth factors. It may not come as a surprise that largest importers of pulses in world is India and in the year 2018 it has imported pulses to a staggering amount of 1040 million US dollars (APEDA, 2018).

Plant Protection

According to Subhas Palekar, disease control and prevention in natural farming can be done by locally sourced concoctions like *Neemasatra*, *Agniastra* and various others.

Rana *et al.* (2006) reported that fermented buttermilk and cow urine mixture (1:1) was found to inhibit the pathogen at 10 % concentration. For seed treatment, seeds were also treated with organic inputs and *Beejamrit* was more successful as it resulted in 94.66 % seed germination and also reduced *Pyricularia* infection to 4% compared with control where infection was 24%. Pathania *et al.* (2006) reported that maximum mycelial inhibition of 72.9 % followed by *Panchgavya* with 62.9 % was recorded with cow urine @10 %. When *dashaparni* extract, *Azadirachta indica* leaf extract and *Azadirachta gcapsicum alliums* extract were used instead of a combination of the above bio-organic formulations, the total plant biomass was found to be higher. Sharma *et al.* (2015) found that 10 % aqueous leaf extract of *Polygonum hydropiper* followed by *Panchgavya* @ 10% in capsicum and a module containing soil treatment with *Panchgavya* @ 10% followed by sprays of neem oil at 10-day intervals, respectively, were effective against mustard aphid. *Panchgavya* and *Lantana camara* were proven to be highly effective aphidicides against cowpea and okra aphids. Lower cost of cultivation, no toxic effects, no toxic effect on environment and have no residual effect these all-good impacts are linked to organic insecticides.

Other organic pesticides and insecticides are also available in market as *Chrysanthemum* based pyrethroids and *neem*-based insecticides as *Achook* and various others.

Vocal critique of ZBNF

The government should not spend financial and human resources promoting ZBNF, which is behind in terms of production and productivity, and will result in a significant setback to the goal of food security according to Panjab Singh, president of the National Academy of Agricultural Sciences (NAAS). Indian soil is deficient in many nutrients and *Jeevamrit* is not able to supply all the nutrients in the required amount and time. Natural farming uses traditional varieties that yield lower than high yielding varieties (HYV). Many scientists calling it a half-baked concept which overthrows the whole idea of two centuries study of soil chemistry and fertility. It is basically considered as more of naturistic and philosophical way of farming rather logical and scientific way of doing it. It is fairly new concept rather an untested one that needs a scientific validation from the farmers, scientists, policymakers and NGOs across the country. The Subhas Palekar natural farming (SPNF) methods are not new discovery and products obtained from desi cows were used in pre-green revolution era and that resulted in famine, low crop productivity, hunger and several other predicaments that has been proven albatross for food security at national level and this farming system should not entrusted with farmers money, time and resources. As its adoption rate is increasing it can be seen as threat to capitalist industries of fertilizers, pesticides and several other agricultural chemicals. There is the trend that positively correlates the increases in use of NPK fertilizers has increased the yield.

ICAR/NITI Aayog view of ZBNF

In the *Business Standard* Vice- Chairman NITI Aayog wrote a two-part article on ZBNF. He described it as a "unique and proven solution for environmental degradation and farmer distress". He wanted it quickly scaled up without awaiting certification from some "respected foreign institutions". With ZBNF, he said, "Indian agriculture can emerge as an example for the rest of the world". Speaking to The Print, Trilochan Mohapatra, Secretary, Agricultural Research and Education, said: "Trials are going on in Modipuram (Uttar Pradesh), Ludhiana (Punjab), Pantnagar (Uttarakhand) and Kurukshetra (Haryana). It will take at least two to three years to get results. We will only launch the scheme then." Mohapatra added that a team has been constituted under Telangana University vice-chancellor Dr Praveen Rao and Prof. Jaishankar of the same university to oversee the trials. The plan is to expand the tests to 20 other locations. Natural farming overthrows the whole idea of father of fertilizer industry 'Justus Von Liebig' law of restitution and calls him Mr Lie Big. In my conclusion I want to say that it is a very unique and tailored fit farming system for small and marginal farmers to uplift them from poverty. In terms of soil health, it is an excellent idea as it doesn't rely on chemicals for growth and development but uses native micro-flora for nutrients and also makes soil sustainable and healthy.

Conclusion

Beejamrit was seen to result better germination percentage than any treatment and cow urine is known to have antibiotic effects. *Jeevamrit* was unable to provide all the adequate nutrients in the required time but in combination with other organics like vermicompost, FYM and *Panchgavya*, it has shown better results than other treatments. The increase in native earthworm species increased water-holding capacity and aeration that make the crops less dependent on irrigation. The low cost of preparation of *Beejamrutha* and *Jeevamrit* certainly has edge over chemical fertilizers and other seed treatments. Nature farming is one of the highways through which India can achieve all sustainable development goals and inspire a million more to adopt it. Adoption of ZBNF will remove the extra burden of fertilizers and other chemicals imports, taxes and fertilizers subsidies which will certainly save thousands of crores of government money. Maintenance of soil fertility through crop rotation was an old idea but effective one and use of agro-forestry to conserve soil and water erosion is also effective and it will also give extra income. The use of neem products and black pepper also found effective because of less incidence of pest and disease due to zero application of chemical nitrogen and more resilient traditional seeds varieties. But it was worth notable that there was no measure to counteract weeds and their ill effects as we all know that weeds cause about 33% loss in crop productivity and this coupled with low efficiency of *Jeevamrit* will jolt the crop productivity and hence, in the era of food security we cannot afford to suffer from low productivity. Economic survey has dedicated a section to natural farming dictating its ecological benefits to soil fertility and water stress. Subhas Palekar natural farming (SPNF) has a great potential among low income farmers but wide research across every ecological situation with willingness by policymaker will inspire the world to adopt chemical free farming. Conventional farming has ensured that India produce enough grain to export but the modern farming system has become unsustainable as the yield is decreasing along with ecological contamination and financial troubles for farmers make it dysfunctional. In the 21st century we have to find an alternative that doesn't compromise our battle with poverty and hunger along with sustaining nature.

Acknowledgement

I would like to thank Dharmik. G. Borisagar for supporting this review with economics data and Disha Patiyal for her constant support in writing this review article.

Conflict of interest

The authors declare that they have no conflict of interest.

References

Akarsh, S., Pavithra, G.R., Roopa, K.N., Ranjitha, M.C., & Kekuda, T.R.P. (2016). Antifungal Activity of Cow Urine Extracts of Selected Plants against Phytopathogenic. *Scholars Journal of Agriculture and Veterinary Sciences,* 305-308.

Aulakh, C.S., Singh, H., Waliya, S.S., Phutela, R.P., & Singh, G. (2018). Evaluation of nutrient sources for organic production of rice (*Oryza sativa*)–wheat (*Triticum aestivum*) cropping system in north-west India. *Indian Journal of Agronomy, 63*(2)*,* 137-144.

Belel, M.D., Halim, R.A., Rafii, M.Y, & Saud, H.M. (2014). Intercropping of cornwith some selected legumes for improved forage production: A review. *Journal of Agricultural Sciences, 6*(3), 48–62.

Chadha, S., Rameshwar, Ashlesha, Saini, J.P., & Paul, Y.S. (2012). Vedic Krishi: Sustainable livelihood option for small and marginal farmers. *Indian Journal of traditional Knowledge, 11*(3), 480-486.

Chakraborty, D., Nagarajan, S., Aggarwal, P., Gupta, V.K., Tomar, R.K., Garg, R.N., Sahoo, R.N., Sarkar, A., Chopra, U.K., Sarma, K.S.S., & Kalra, N. (2008). Effect of mulching on soil and plant water status and the growth and yield of wheat (*Triticum aestivum L.*) in a semi-arid environment. *Agriculture Water Management*, *95,* 1323-1334.

Chakraborty, D., Garg, R.N., Tomar, R.K., Singha, R., Sharma, S.K., Singh, R.K., Trivedi, S.M., Mittal, R.B., Sharma, P.K., & Kamblea, K.H. (2010). Synthetic and organic mulching and nitrogen effect on winter wheat (*Triticum aestivum L.*) in a semi-arid environment. *Agricultural Water Management, 97,* 738–748.

Chandrakala, M. (2008). Effectof FYM and fermented liquid manures on yield and quality of chilli (*Capsicum annuum* L.). M.Sc. Thesis. University of Agriculture Science, Dharwad.

Chongre, R., Mondal, R., Biswas, S., Munshi, A., Mondal, R., & Pramanick, M. (2019). Effect of Liquid Manure on Growth and Yield of Summer Green Gram (*Vigna radiata* L. Wilczek). *Current Journal of Applied Science and Technology,* 1-7.

Galab, S., Reddy, P.P.D., Raju, D.S.R., Ravi, C. & Rajani, C. (2019). Impact Assessment of Zero Budget Natural Farming in Andhra Pradesh – *Kharif* 2018-19. ZBNF Issue Brief. http://www.vedicbooks.net/principles-spiritual-farming-volume-p-14779.html.

Gitari, H.I., Nancy, Karanjaa, N., Charles, K.K., Gachenea, Kamaua, S., Sharma, K., Geldermannb, S.E. (2018). Nitrogen and phosphorous uptake by potato (*Solanum tuberosum* L.) and their use efficiency under potato-legume intercropping systems. *Field Crops Research, 222,* 78–84.

Jalota, S.K., Khera, R., Arora, V.K. & Beri, V. (2007). Benefits of straw mulching in crop Production: A review. *Journal of Research, Punjab agricultural University, 44*(2), 104-107.

Jandaik, S., Thakur, P., & Kumar, V. (2015). Efficacy of Cow Urine as Plant Growth Enhancer and Antifungal Agent**.** *Advances in Agriculture,* 1-7.

Jordan, A., Zavala, L.M., & Gil, J. (2010). Effects of mulching on soil physical properties and runoff under semi-arid conditionsin southern Spain*. Catena, 81,* 77–85.

Khadse, A., Rosset, P. M., Morales, H., & Ferguson, B. G. (2018). Taking agroecology to scale: The zero-budget natural farming peasant movement in Karnataka, India. *The Journal of Peasant Studies*, *45*(1), 192-219.

Khadse, M., & Rosset, P.M. (2019). Zero Budget Natural Farming in India – from inception to institutionalization. *Agro-ecology-and-sustainable-food-systems, 43*(7), 848–871.

Kumar, S.S., Punam, Saini, J.P., & Chadha, S. (2014). Management of aphid pest by growing organic input in organically grown crops. *International Journal of Agriculture Science & Veterinary Medicine, 2*(1), 116-121.

Kumar, A., Shiri, T., Jain, S., Kushwaha, A., & Tyagi, N. (2019). Studies on indigenous cow (*Bos indicus*) based bio-organic formulations (BOFS) in tomato cultivation for increasing soil health stipulation. *Journal of Plant Development Sciences, 11*(1), 20-29.

Lahariya, G.S., Patil, D.U., & Damare, P.R. (2013). Effect of organic sources on soil fertility, nutrient uptake and yield of soybean. *Crop Research, 45*(1), 155-159.

Mulumba, L.N., & Lal, R. (2008). Mulching effects on selected soil physical properties. *Soil & Tillage Research, 98,* 106–111.

NAAS. (2019). Zero Budget Natural Farming - A Myth or Reality? Policy Paper No. 90, National Academy of Agricultural Sciences, New Delhi: 20

Palekar, S. (2005). The philosophy of spiritual farming I. 2nd ed. Amravati: Zero Budget NaturalFarming Research, Development & Extension Movement, Amravati, Maharashtra, India.

Palekar, S. (2006). The principles of spiritual farming II. 2nd ed. Amravati: Zero Budget Natural Farming Research, Development & Extension Movement, Amravati, Maharashtra, India.

Pathania, R., Thakur, B.R., & Rana, D. (2019). Efficacy of organic products against *Fusarium oxysporum* f. sp. *Ciceris Plant Disease Research*, *34*(1), 51-53.

Rana, D., Paul, Y.S., & Upmanyu, S. (2016). Organic management of paddy blast using indigenous technical knowledge based organic inputs**.** *Plant Disease Research*, *31*(1), 15-18.

Sangakkara, U.R., Richner, W., Schnider, M.K. & Stamp, P. (2003). Impact of intercropping beans (*Phaseolus vulgaris L.*) and sunhemp (*Crotalaria juncea L.*) on growth, yields and nitrogen uptake of maize (*Zea mays L.*) grown in the humid tropics during the minor rainy season. *Maydica, 48,* 233–238.

Sekhon, N.K., Hira, G.S., Sidhu, A.S., & Thind, S.S. (2005). Response of soybean (*Glycine max Mer.*) to wheatstraw mulching in different cropping seasons. *Soil Use and Management, 21,* 422–426.

Shaikh, N.F., & Gachande, B.D. (2015). Correlation between Soil Mycoflora and Productivity under Influence of Organic and Inorganic Inputs Applied Field of *Cajanus cajan*. *International Journal of Science and Research, 5*(1), 191-195.

Sharma, C.R. & Banik, P. (2015). Baby Corn-Legumes Intercropping Systems: I. Yields, Resource Utilization Efficiency and Soil Health, *Agroecology and Sustainable Food Systems, 39*(1), 41-61.

Shubha, S., Devakumar, N., Rao, G.G.E., & Gowda, S.B. (2014). Effect of Seed treatment, Panchagavya application and Organic Farming Systems on Soil microbial population, Growth and Yield of Maize. Proceedings of the 4th ISOFAR Scientific Conference. *'Building Organic Bridges',* at the Organic World Congress 2014, 13-15 Oct., Istanbul, Turkey (23483).

Shwetha, B.N., & Babalad. (2008). Effect of nutrient management through organics in soybean wheat cropping system. *M. Sc. (Agri.) Thesis*, University of Agricultural Sciences, Dharwad, Karnataka.

Sreenivasa, M.N., Naik, N., & Bhat, S.N. (2009). Beejamrutha: A source for beneficial bacteria. *Karnataka Journal Agriculture Science, 22*(5), 1038-1040.

Sujana, S., Kohale, V.S., Gawali, K., Khadse, K. & Nagmote, A.V. (2019). Effect of FYM and organic solutions on yield and quality of chilli (*Capsicum annum* L.). *Journal of Pharmacognosy and Phytochemistry, 8*(5), 251-254.

Swain, S.C., Dora, D.K., Sahoo, S.C., Padhi, S.K., & Sanyal, D. (2012). Influence of mango-based intercropping systems on improvement of soil health under rainfed situation. *Communications in Soil Science and Plant Analysis, 43*(15), 2018-2026.