Online ISSN 2582-368X

AGRIALLIS

SCIENCE FOR AGRICULTURE AND ALLIED SECTOR

A Monthly Magazine

VOLUME 4,
ISSUE 5
MAY 2022

www.agriallis.com

Growing seed

Editorial Board

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AGRIALLIS
Science for Agriculture and Allied Sector: A Monthly Magazine

Article Id
AL04127

ZERO BUDGET NATURAL FARMING- A STEP TOWARDS SUSTAINABLE FUTURE OF AGRICULTURE

[1]Neha* and [1]Monika Sharma

Email

neha7233s@gmail.com

[1]Research Scholar, Department of Agricultural Communication, College of Agriculture, GBPUA&T, Pantnagar, India

Agriculture is the primary livelihood source of 58 percent populations in India. Green revolution became most popular in the early 1960s with the purpose of increasing food production by adopting advanced methods and technologies such as the use of High Yielding Variety (HYV) seeds, advanced technologies, irrigation facilities, pesticides, and fertilizers,etc. With that the major drawbacks of green revolution was confined only for a few crops such as wheat, paddy, and maize but also for few areas of countries such as Punjab, Haryana, and Western Uttar Pradesh and is costly also. The farming community has found themselves in the vicious cycle of debt with the high input production costs, high-interest rates for credit, the volatile market prices for crops, the rising costs of fossil fuel-based inputs and private seeds, etc. and they are unlikely forced to take loan from money lenders and institutional sources.

Many agricultural scientists argue that excessive usage of chemicals in the field is not only proving counter-productive in the long term sense, but also it has irreparable damage to soil health and environment as well. So, the biggest challenge is improving the soil health of cultivated land by using non-chemicals to attain sustainability in production and to improve the quality of food. For that, an eco friendly or farmer's friendly alternate system of farming is now becoming most popular among the farming community is Zero Budget Natural Farming, which is crucial in achieving the ambitious goal of doubling farmer's income by 2022 with low input cost and to support sustainable agriculture.

Concept of Zero Budget Natural Farming

Zero Budget Natural Farming is a unique method of chemical free agriculture through indigenous practices pioneered by agricultural scientist Subhash Palekar, in Karnataka. In the mid of 1990s as an alternative to the green revolution's method to reduce the use of chemical

fertilizers and pesticides and intensive irrigation methods as well as. ZBNF is based on agro-ecology and also called as Zero Budget because the aim is to bring down the cost of production and in which there is no need to spend too much credit to farmers on buying inputs such fertilizers, pesticides, insecticides, and intensive irrigation practices and get back on pre-green revolution or traditional style of farming. Further, Palekar claims that rising cost of inputs has always been not only a major cause of indebtedness but also leads to increase of suicide cases among farmers, whereas at the same time the impacts of chemicals on the environment and soil fertility is devastating.

Hence, with ZBNF there is no need to expend too much money on such inputs or while borrowing loans from middlemen. With a greater extent the cost of production could be reduced and farming could be made into a zero budget. Thus, this will help in breaking the debt vicious cycle for many small and marginal farmers. Apart from this, ZBNF helps to improve the soil health and enriches with essential nutritive elements and also provide the environmental benefits. The ZBNF also supports soil aeration, minimal of watering, intercropping, bunds and topsoil mulching and discourages intensive irrigation and deep ploughing methods. Although, Palker is not in favor of vermin-composting, as which is the cornerstone of typical organic farming, the reason is that it does not prevent from toxic metals, the most common composting worm in ZBNF is the European red wiggler (*Eisenia fetida*) to Indian soils, these worms absorb toxic metals and poison groundwater and soil. Hence, the ZBNF is mainly based on chemicals free agriculture, which is drawn from traditional Indian practices at field conditions.

The four pillars of ZBNF

The four pillars and some traditional practices of ZBNF are following;

1. Jeevamrutha/Jivamrita: Generally, this traditional practice is based on a fermented microbial culture. It provides nutrients to the soil. It acts as a catalyst agent to grow the activity of microorganisms and also increases earthworm activity in the soil. The duration period of fermentation process is about for 48 hour, during this process the aerobic and anaerobic bacteria present in the cow dung and urine multiply as they feed the pulse flour in the solution, which is an organic ingredient. Further, a handful undisturbed soil is also added to the preparation to immunize native bacteria and other organisms as well as. Jeevamrutha also helps to protect the plants against fungal and bacteria plant diseases. This practice is only

needed in the starting 3 years of the transition, thereafter the whole system become self-sustaining themselves.

Preparation: It is made up of cow dung (10 Kg), cow urine (10 lit), jaggery (2Kg), pulse flour (2Kg) in the 200 lit of water. Thereafter, the solution has to be stir thoroughly and then let it be fermented for 48 hours in the shade.

Application: Generally, the prepared mixture of 200 liters of Jeevamrutha is enough for one acre of land. It has to be applied to the crops twice a month with irrigation water or as 10% foliar spray.

2. Bijamrita/Beejamrutha: Beejamrutha is a treatment of seed, seedlings and planting material. It is very effective to protect young roots from fungus, soil-borne and seed-borne diseases, which is mainly affected during the monsoon. It is made up of local cow dung (having natural fungicide), and cow urine (having anti-bacterial liquid), lime and a handful soil. Further, Beejamrutha is added to the seeds of any crop, coat them properly, and mixing them thoroughly by hand; then let it be dry well and then use it for sowing. For treating leguminous seeds, just quickly dip them and let them dry well for a while.

Preparation: The mixture of Beejamrutha is made up of cow dung (5Kg), Cow urine (5 lit), water (20 lit), lime (50 g), and a handful soil.

3. Mulching: Mulching practice helps to conserve soil moisture by reducing evaporation. Mulching can be done by three types are described below:

a) Soil Mulching: Protects topsoil during cultivation. Due to this soil does not destroy by tilling. It also helps to enhance aeration and water retention in the soil. Palekar suggested that one should avoid the deep ploughing, as it will affect active microorganisms in the soil.

b) Straw Mulching: It is the dried biomass waste of previous crops. It can be composed anywhere, when soil is covered with the dead materials of any living organism such as plants, animals, etc. This practice is done to improve the soil fertility rate where dry organic material decomposes and form humus through the activity of the soil biota, which is activated by microbial.

c) Live Mulching (Symbiotic intercrops and Mixed crops): This practice is pivotal to develop multiple cropping patterns of monocotyledons (Monocots; Monocotyledons seedling have one seed leaf) and dicotyledons (dicotos; Dicotyledons seedling have two seed leaf)

grown in the same field, which is done to supply all essential elements or nutrients to the soil and crops as well as. Further, legumes are categorized under the dicot group as they are nitrogen-fixing plants. Whereas rice and wheat are monocots because they are essential to supply elements like potash, phosphate and sulphur to soil and crops.

4. Waaphasa – Moisture: Palekar claims that plant roots do not require too much water for irrigation, but the plant roots need only water vapor. Waaphasa is the condition in which both air and water molecules are presented in the soil which helps to reduce the requirement of irrigation. He suggested that irrigation should be reduced and used it only at during noon.

Advantages:

- Farmers practicing ZBNF gets higher yields at low input cost.
- Eliminates the usages of chemical pesticides and promotes good agronomic practices.
- Promotes regenerative agriculture, improve soil biodiversity and productivity.
- Ensures decent livelihoods to smallholder farmers.
- Restores or enhances the ecosystem's health through diverse, multi-layered cropping systems.
- Anyone who is having half an acre of land can start with ZBNF at low cost.
- Using ZBNF techniques, one can convert even the most infertile land into a fertile one.
- Helps to ensure Women's empowerment.
- Enhances the nutritive value and quality of food without any implementation of chemicals.

Government initiatives to promote ZBNF

- Government of India has been promoting organic farming through the schemes of Paramparagat Krishi Vikas Yojana (PKVY) and Rashtriya Krishi Vikas Yojana (RKVY).
- In the revised guidelines of PKVY scheme during the year of 2018 included various organic farming models like Natural Farming, Zero Budget Natural Farming (ZBNF) Rishi Farming, Vedic Farming, Cow Farming, Homa Farming, etc. and flexibility is given to states or depending on farmer's choice to adopt any model of organic farming including ZBNF.

- In the RKVY scheme, organic farming/ natural farming project components are considered by the State Level Sanctioning Committee (SLSC) according to their priority/choice.

Conclusion

Across the world, agriculture is facing multiple problems in the form of extreme changes in climate like floods and droughts or other factors such as soil degradation due to excessive use of chemical fertilizers, soil salinity and water shortage. Therefore, to ensure food security, producing more with optimum use of available resources with minimum cost and building the resilience of smallholder and marginal farmers are very important in agriculture sector. Consequently, agricultural scientists suggested that it's as time when we need to rework on traditional strategies so that farming would be compatible with nature. Hence, there is a need of global transition to a more resilient and sustainable agriculture, which is less dependent on use of agrochemicals and mainly draws more on natural biological and ecosystem processes. So, the new system of farming which is based on zero budget will freed the farmers from the dept trap and it also helps to make farming as an economically viable venture.

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AGRIALLIS
Science for Agriculture and Allied Sector: A Monthly Magazine

Article Id
AL04128

GYPSUM AS AN AGRICULTURAL AMENDMENT IN ACID SOILS

Email

dorukkasi@gmail.com

Kasinam Doruk

Research Scholar, College of Agriculture, Central Agricultural University
Imphal, Manipur-795004, India

"Agriculture has failed to be sustainable several times in the history of the world because of soil failure" - Rush (1987)

Gypsum **(Calcium sulfate dihydrate)** is a naturally occurring mineral that is made up of calcium sulfate and water ($CaSO_4.2H_2O$) that is sometimes called hydrous calcium sulfate. It is the mineral calcium sulfate with two water molecules attached. Gypsum has 23% calcium and 18% sulfur and its solubility is 150 times that of limestone, hence it is a natural source of plant nutrients. By weight it is 79% calcium and 21 % water. Gypsum naturally occurs in sedimentary deposits from ancient sea beds. Gypsum is mined and made into many products like drywall used in construction, agriculture and industry. It is also a by-product of many industrial processes.

Acid soil often has high amounts of aluminium and low amounts ofccalcium. Since high levels of aluminium are toxic to plants, this effect often forms a barrier and prevents root penetration. his is a common problem in weathered soils from humid areas with lots of rainfall. If we use enough lime to correct this problem it changes the Ph to the point where other nutrients become locked up and unavailable to plants. Gypsum adds the required calcium to the soil without changing the Ph.Ca improve porosity and aeration especially in clay soil which have a very fine texture. After application of calcium ,clay soil expand its size and become loosely and can stored water that overall water holding capacity. In general gypsum is a sedimentary mineral. It can reduce aluminium toxicity in acid soil,atPh lower than 4.5 aluminium in soil overpowers the ability of hydrogen ions to increase pH. Gypsum in acid soil while the calcium will displace hydrogenions; these ions will remain in solution and will not adjust soil Ph. Gypsum is more soluble than lime and can add calcium more rapidly to the soil.


Gypsum on sodic soils(salty soils) the calcium in gypsum substitutes for the sodium, allowing for the sodium to leach away. When gypsum is exposed to moisture it dissolves and the ions separate into calcium and sulfate ions. When sodium is on the surface of clay particles it causes hydration and the dissociation of the particles, hence swelling and dispersion. The calcium ion from gypsum replaces the sodium ion and allows it to be dissolved and leach away, removing it from the soil profile. An increase in soil sodicity (Na+) increases soil susceptibility to crusting, sealformation, runoff and erosion. Gypsum replaces sodium and leached downward and out of reach of plant roots.

Soils with lots of surface area, such as those with high clay content, tend to have higher matrix potential at a given water concentration. In osmotic flow, water moves from an area of low salt content to an area of higher salt content. Soils with lots of salt may look moist but plants can not absorb this moisture due to this effect. Hence, Gypsum helps reduce this effect and helps plants use the moisture stored in the soil.

Gypsum is not acid soluble and will not change the soil pH. It helps to shift the Ca and Mg levels in soil and offers a readily available form of sulfate sulphur, a valuable secondary nutrient that benefits the soil and crop. The sulfate in gypsum binds with excess Mg in the soil to form soluble Epsom salt, which moves lower into the soil profile. This Mg is replaced by Ca, improving water holding capacity, root development and soil quality.

Some Interesting Fact about Gypsum

- Gypsum is neutral in soil ph, and since it has no carbonate(CO3) ion as part of its make up, it will not neutralize acidity. However, it is much more soluble than most

lime products (about 200 times as soluble),so it does make a very good source for soluble calcium and sulfate.

- Gypsum is a sulphate of calcium and is a neutral salt in water(neither alkaline nor acid).
- Like gypsum, limestone(CaCO3) contains calcium in the form of calcium carbonate.However,it is not calcium that increases the Ph but rather carbonate, by neutralizing acid(hydrogen ions). Gypsum shouldn't be used as a limestone substitute but as a fertilizer supplement to provide calcium and sulfate, both of which plants need for healthy growth.
- Treats aluminium toxicity in acid soils.
- Soluble calcium enhance soil aggregation and porosity
- Addition of soluble calcium can overcome the dispersion effects of magnesium or sodium ions and help promote flocculation and structure development in dispersed soils.
- Multivalent cations include Ca2+(Two positive charge)help hold soil particles together because they can have electrostatic (magnetic) attraction between two or more negative charge sites.
- On acid soils, Hydrogen ions which do not migrate rapidly in soils containing clay.It is suggested that the sulfate from gypsum forms a complex aluminium sulphate with aluminium which renders the aluminium non-toxic and are also non-toxic to plants.
- In general, Without adequate calcium, uptake mechanisms would fail.

Conclusion

Gypsum has a high potential to increase the soil fertility especially in the sub soil due to high solubility of Ca, and S.Gypsum directly improves base saturation, and exchangeable Ca and S content in soil.

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AGRIALLIS
Science for Agriculture and Allied Sector: A Monthly Magazine

Article Id
AL04129

INLAND FISHERIES LEGISLATION IN INDIA

Email

haricof92@gmail.com

Hari Prasad Mohale

Department of Fisheries Biology and Resource Management
Fisheries College & Research Institute, TNJFU, Thoothukudi- 628 008.
Tamil Nadu, India

In India, the idea regarding the conservation of fisheries resources of rivers was given by Sir Arthur cotton during sixties of the last century. He was in charge of a number of dams and weirs being constructed at that tie on the rivers of south India (Datta and Das, 2013). He feared that these structures might adversely affect the local inland and coastal fisheries. The Government of India deputed Dr. Francis Day in 1869, to investigate the freshwater fisheries and to draw up a scheme with a view to institute a special and necessary legislation for better protection of the fisheries of the country. Sir Francis Day, after a thorough investigation of many years published two reports in 1873, viz,"freshwater fish and fisheries of India and Burma", and "The Sea Fish and Fisheries of India", in which he drew the attention of the Government to the widespread slaughter of ripe fish, fry, and fingerlings. He also pleaded the urgency to adopt legislative measures to conserve the fisheries resources (Ayappan *et al.*, 2006). Nothing was done for many years. By 1888, the question again forced its way to the front, and it was considered by the Agricultural Conference held at Delhi in that year (Singh, 2004). The Government of India enacted the Indian Fisheries Act, which came into being in 1897 (as it received the assent of the Governor General of India on the 4th February, 1897).

Relevance of Legislation in Inland Fisheries

The brief in the inexhaustibility of capture fishery resources has been belied since long. Experience has shown that uncontrolled fishing and highly destructive devices of fish capture deplete fishery resources and are followed by great economic distress. The purpose of fishery regulations is to obtain maximum sustained yield of fish from waters and assure a recurring bountiful harvest of fish without depleting the resources and wastage of fishing effort. The basis of empirical regulations is the belief that every fish should be given a chance

to breed at least once. By way corollaries to this belief the following notions may be mentioned (Singh, and Gupta, 2018).

- That it is necessary to have a large number of spawners of a species;
- That all smaller fish must be protected as the majority will mature and become spawners;
- That is very essential to protect fish during the spawning season.

Indian Fisheries Act Of 1897 and Rules Framed There Under In Various States

The salient features of the Indian fisheries act 1897 are as follows:

1. (i) This act may be called the Indian Fisheries Act, 1897.
(ii) It extends to the whole of India, except Burma
(iii) It shall come into force at once.

2. Subject to the provisions of section 8 and 10 of the General Clause Act, 1887, this act shall be read as supplemental to any other enactment for the time being in force relating to the fisheries in any part of India except Burma.

3. In this act, unless there is anything repugnant in the subject or context

(i) Fish includes shell fish.
(ii) Fixed engine means any net, cage trap or other contrivance for taking fish, fixed in the soil or made stationary in any other way.
(iii) Private-water means which is the exclusive property of any person, or in which the person has for the time being as exclusive right of fishery whether as owner, lessee or any other capacity.

Explanation:- water shall not cease to be "private water" within the meaning of this definition by reason only that other person may have by custom a right of fishery therein.

4. (i) If any person uses any dynamite or other explosive substance in any water with intent thereby to catch or destroy any of the fish that may be therein, he shall be punishable with imprisonment for a term which may extend to two months, or with fine which may extend to two hundred rupees;

(ii) In substance (i) the word "water" includes the sea within a distance of one marine league of the sea-coast; and an offence committed under that subsection in such sea may be tried, punished and in all respects dealt with as if it had been committed on the land abutting coast.

5. (i) If any person puts any poison , lime or noxious material into any water with intent thereby to catch or destroy any fish, he shall be punishable with imprisonment for a term which may extend to two month, or with fine which may extend to two hundred rupees.

(ii) The local Government may, by notification in the official Gazette, suspend the operation of this section in any specified area, and may in like manner modify or cancel any such notification.

6. (i) The local Government may make rules for the purpose hereinafter in this section mentioned and may by a notification in the official Gazette apply all or any of such waters, not being private water, as the local Government may specify in the said notification.

(ii) The local Government may also by a notification, apply such rules or any of them to any private water with the consent in writing of the owner thereof and of all persons having for the time being any exclusive right of fishery therein.

(iii) Such rules may prohibit or regulate all or any of the following matters, that is to say:

a) The erection and use of fixed engines;
b) The construction of weirs; and
c) The dimension and kind of the nets to be used and the modes of using them.

(iv) Such rules may also prohibit all fishing in any specified water for a period not exceeding two year.

(v) In making any rules under this section the local Government may

a) Direct hat a breach of it shall be punishable with fine which may extend to one hundred rupees and, when the breach is continuing breach, with a further fine which may extend to ten rupees for every day after the date of the first convention during which the breach is proved to have been persist in; and

b) Provide for

- The seizer, forfeiture of and removal of fixed engines erected or used, or nets used, in contravention of the rule; and

- The forfeiture of any fish taken by means of any such fixed engine or net.

(vi) The power to make rules under this section is subjected to the connection that they shall be made after previous publication;

(vii) **(i)** any police officer, or other person specially empowered by the local Government in this behalf, either by name or as holding any order from the time being, may without an order from a magistrate and without warrant, arrest any person committing his view any offence punishable under section 4 or 5 under any rule under section 6-

a) If the name and address of person are unknown to him, and
b) If the person declines to give his name and address, or if there is reason to doubt the accuracy of the name and address if given

(ii) A person arrested under this section may be detained until his name and address have been correctly ascertained (Ayappan *et al.*, 2006).

It is in no doubt, that the implementation of the Indian Fisheries Act, 1897 proves to be an essential criteria to preserve fish and fishery resources intact.

The Indian Fisheries Act, 1897, implemented in different states of India as follows

A. Restriction on types of gear and mesh: The minimum mesh size for nets permitted is 30 mm so that smaller fish are not caught. However, nets of smaller meshes are permitted to be used in the marginal area and some reservoirs of Andhra Pradesh and Tamilnadu. In Delhi, since 1948 restriction have been imposed on fishing except with rod and line, hand line and long line or any other net less than 1.5 inch square mesh from July1 to 10 August 30, every year. Mesh regulation is also observed in Manipur, Andaman and Nicobar Islands. In Assam, the size of gaps in bamboo fencing used for fishing have been limited. Restriction have been imposed on the use of certain nets during specified parts of the year, as well as on the mesh sizes of nets of Assam, Maharashtra, M.P., Punjab etc. From 1st April to 15th of June drag net of having mesh size of 2.2 inch are not allowed of any water body of Assam (Paukert et al., 2016).

B. Restriction on size of the fish to be caught: Many states have prohibited the catching of economical fishes having size below 25 cm so that every fish get a chance to breed at least once in its lifetime. Restrictions are also imposed on the sale of undersized fishes. In 1956, Punjab state Government prohibited catching of rohu, catla, mahseer and mrigal smaller than

25.4 cm long. In Delhi, the capture and sale of these species below 20.4 cm in length has been prohibited since 1948. The state of Uttarpradesh has prohibited, since 1954, the capture and sale of fry and fingerlings of major carps, 5.1-2.5.4 cm in length from July 15 to Sept. 30 and of breeders from June 15 to July 31 in the prohibited areas, except under a license issued by the proper authority. In M.P. a size limit of 22.9 cm was imposed in 1953, for the capture of rohu, catla, mahseer and mrigal (Cowx and Gerdeaux, 2004).

C. Closed season: Closed season is followed in Bihar, Madras, Jammu and Kashmir, M.P., Mysore in all large reservoirs, fishery is closed from June-July to end of September so that fishers are not hampered during their spawning migrations and allowed to breed at least, once. Fishing is closed from 1st July to 15th September in the entire state of Rajasthan. However, at Jaisamabad, there is no restriction with regard to mesh or the fish size and no closed season is observed (Sass et al., 2017).

D. Declaration of sanctuaries or protected waters: About 3.2 km of river stretches below the dams Mettur, Tungabhadra and Gandhisagar have been declaired in sanctuaries. Sanctuaries have been declared in Assam, Bihar and Punjab. Delhi, U.P., M.P., T.N., J&K, A.P., also observe restrictions on fishing in prohibited waters. In J&K prohibition has been imposed on the extraction of Hakreza, awter nuts, aquatic plants are gravel or stones during the spawning season of fish in reserved and protected waters from November to February except with the permission of authorities concerned. In Kerala, restriction has been imposed against attracting prawn into private water except under license. In T. N., fishing is prohibited in rivers Cauvery, Harangi, Sampaja and Barapole and their tributaries during the period March 15 to June 1. Cauvery Bridge to its confluence with Ellis. In hariyana, conservation and development measures have been adopted in the portion of Uhlriver and Lambadug and their tributaries situated in the Mandi distict, Pabar river and Bapsa river situated in the district of Mahasu (Midway et al., 2016).

E. Leasing of lackes and reservoirs in alternate years: This is followed in Madhya Pradesh.

- **Prohibition on indiscriminate fishing:** In M.P., Madras, Kerala, Haryana ,Panjab, and in Delhi fishing by means of fixed engine or construction of weirs are prohibited.
- **Ban on the use of explosives or poisonous substances:** Various states such as U.P., A.P., Kerala, J&K, Karnataka, Rajasthan, Kerala, Himachal Pradesh, Delhi, Coorg

banned the use of poisons and explosives for fishing. In Assam, the pollution of the water by retting of jute had been prohibited since 1953 (De Graaf et al., 2015).

Constraints and Suggestions

a) **Fishing right:** In some of states fishing rights of notified water (river, canal, reservoir, tanks, beels etc.) is not vested with the fishery department. These are based by other department like riverine department (as in Assam state) and by irrigation departments as in Punjab and Haryana. Fresh legislation should be made vide with fish rights of all these water bodies should vested with states Fisheries department.

b) **Check at fish market:** At present, there is hardly any legislation for the checking of stale of rotten fish in the market. Fisheries department can be interested with the job of checking market allowed on the sale good quality fish.

c) **Control of village ponds:** At present, all the village ponds are under the control of village panchayat. Sometimes these tanks are note leased out for fishery and they remain fallow. The control of village ponds should be handed over to fisheries department and fishery official should be made responsible for their development.

d) **Adoption of Fisheries Legislations by all states Governments:** Many of the states like West Bengal and other states in the North East region had no fishery legislation for the conservation of the fishery resources. Some states have taken some measures but only in limited area. All the state Governments should make laws and rules to conserve their fisheries resources (Midway et al., 2016).

Guidelines on regulations of Inland Fisheries

1. Resources to be covered: Rivers, streams and associated waters, floodplain lakes, wetlands, reservoirs, canals, estuaries and lagoons, mangrove wetlands, backwaters, natural and manmade lakes (reservoirs) and their variants (John Wiley and Sons, 2008).

2. Craft and gear:

- Fishing devices such as seine and gill nets, boats (mechanized or non-mechanized), traps, spears and other implements, which are employed for catching fish are referred to as the crafts and gear

- The states or any other authorized agency by the state/union territory shall restrict, regulate or prohibit the use of fishing crafts and gear, which are deemed as destructive in nature so as to conserve to biodiversity in general and endangered species in particular.
- The state shall adopt the precautionary to approach to regulate the use of fishing gear so as to protect fish species of commercial value from over-fishing or fishing at undesirable size (Rajesh, 2013).

3. Control, regulation and ban on destructive crafts and gear:

- The state shall not allow the use of non-prescribed gear of any kind for catching fingerlings, juveniles, larvae of fish which affect the stock or species or are against the prescribed norm of responsible fishery, including minimum legal size of capture.
- Fishing crafts fitted with out-board motors affecting the ecosystem or fish biodiversity in any form shall be regulated or banned.
- Cross nets, such as stake-nets, bag-nets etc. which encroach or affect the migratory pathway of fish and other organism, shall be regulated to facilitate conservation of brood stock and auto- stocking.
- The authorized fishery officer shall have the authority to monitory to monitor and check the type of crafts and gear that are used in open-water ecosystem for catching fish and imposing suitable penalty for violating the normal prescribed types, as mentioned under I, II and III above (Misra, 2006).

4. Untenable fishing practices in inland waters:

- Wanton killing of fish juveniles, fish brooders and other organisms, which otherwise have economic, aesthetic or biodiversity significance, and effects the fishery, shall be treated as cognizable offence and shall be dealt with appropriately. A penalty of Rs. 5ooo or six months imprisonments or both can be awarded depending upon the gravity of offence.

- Wanton killing of fish and associated fauna using poison of plant origin or synthetic dynamite and any other destructive method in open shall be treated as a cognizable act, with a penalty of Rs. 10,000 or one year imprisonment or both.

- Establishment or compartments or structures of any from such as earthen embankments, bamboo screens etc. which obstruct or restrict the movement of fish in any form within the lake/wetland/estuary/lagoon, shall be deemed as cognizable offence except otherwise done in public interest (Agarwal, 2021).

Conservation of stock and resources

- The state shall notify closed season or fishing holidays in open waters like rivers/reservoirs/wetlands for a minimum 60 days during breeding season of commercially important species such as Indian major carps to augment auto-stocking and wanton killing of fish juveniles as well as fish brooder stock.
- The state shall be prepare inventory of deep pools in various riverine stretches and ensure their protection and maintenance. These may be declared as protected areas and the active participation of fisheries, cooperatives, local panchayats and NGOs to conserve fish and other important biodiversity in such deep pools shall be encouraged.
- To protect the physical entity of wetlands/flood lakes, no person or body shall allowed to obstruct the lateral connectivity of wetlands with rivers, especially during flooding, as it acts the passage for the migration of fish brooders to wetlands for breeding and in turn the wetlands act as the natural nursery and feeding grounds for many important riverine fish species (Jingran, 1991).
- The state shall ensure that construction of dam, barrage, bundh, etc. should be preceded by appropriate environmental impact assessment and abatement especially with regard to migration of fishes.
- Encroachment or reclamation of rivers, lakes and wetlands, wither for arable land or human habitation or any other purposes, which leads to colossal loss of aquatic resources and associated utility functions, shall be deemed as a punishable offence.
- The state shall ensure that appropriate environmental impact assessment and abatement measures are carries out before construction of dams, barrages etc. across streams and rivers. Hydraulic structures should include devices to facilitate migration of fish species.
- The state shall ensure the protection of the interest of traditional fishers using traditional crafts and gear (Saxena, 1969).

Leasing/licensing of Open Waters

- The leasing of open-water fisheries, especially the lake, reservoirs, beels, etc. shall be done keeping in view the long term management perspective besides sustainability of endemic biodiversity.
- The lease period for a water body shall not less than five year. However, the state shall have the right to cancel the lease in case the lessee is found wanting or proves to be guilty of violating norms or not adhering to the prescribed guidelines for sustainable fishery.
- Annual rent or lease amount shall be fixed in accordance with the status of production and productivity evaluated duly following scientific principles (Singh, 1989).
- Inventory, licensing and registration of motorized boats should be made mandatory to curb the unchecked growth of such crafts leading to over fishing of target species or threats to biodiversity or to water quality in estuarine and lagoon ecosystems. The state shall fix a rent on each such registered boat in accordance to the types of boats and gear, and average anticipated fish catch per boat per day.
- The state shall have the right to confiscate, impose fine and ban the entry of such unregistered boats or even registered boats using destructive devices to catch fish.
- Dumping of solid wastes in lake/wetland/lagoon area thereby reducing the effective water area besides impairing the water quality or encroachments of any kind shall be treated as an act against the state, as such punishable under this act (Datta and Das, 2005).

Conclusion

It may be concluded that fisheries management is full of complexities. If one part of the problem is tackled, its result may exacerbate the difficulties to other parts. However, there is an immediate and urgent need to introduce appropriate legislative measures for the protection, conservation and management of inland fisheries resources of India based on latest biological and ecological studies. Apart from these, the actual users of the resources, viz, the traditional fishing communities must be consulted and their aspiration taken onto account before the formulation of regulations. After all, when the fisheries legislation is viewed from the human dimensions, these seems to be truth in the old axioms “one does not manage fish, one manage people”.

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AGRIALLIS
Science for Agriculture and Allied Sector: A Monthly Magazine

Article Id
AL04130

ROBOBEES: THE FUTURE OF CROP POLLINATION

[1]Kaushik Pramanik* and [1]Pranabesh Nandi

Email

kpramanik.kaushik@gmail.com

[1]Department of Agricultural Entomology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal- 741252, India

Around three-quarters of all crop species, from apples to almonds, rely on bees and other insects for their pollination. Pesticides, land clearing, and climate change, on the other hand, have caused a decline in many of these animals concerning farmers. Pollination is required for flowering plants to reproduce. In order to form seeds, pollen grains are to be transferred to the stigma of a pistil from the anther. The stamen spills pollen directly onto the pistil in self-pollinating plants. Cross-pollination, on the other hand, entails pollen transport from one plant to another. When bees and other insects eat on flowers, pollen sticks to their bodies and is then deposited on the next plant they visit. It has the advantage of increasing genetic variability and improving crop quantity as well as quality over self-pollination.

Honeybees are referred to as the keystone species because they play a disproportionate function in an ecosystem in comparison to their population size. TheYale University research indicates that one-third of the crops are directly dependent on honey bee pollination. This figure does not include the crops that benefit indirectly from bee pollination. Honeybees and other related insects provided about $29 billion to the agriculture industry in the United States alone in 2010. So, what distinguishes these pollinators from others?

Each plant species necessitates its own pollinator. While mammalian or bird pollinators are too huge, a colony of 50,000 bees gives an exact efficiency. According to the United States Department of Agriculture's Forest Service, the distinctive hairs that encircle many bee species, as well as honeybees' devotion to each owner, allow for effective cross-pollination that promotes healthy future plant generations.

Colony collapse disorder (CCD) is caused by external factors such as the overuse of hazardous chemicals, habitat degradation, and parasites. When worker bees leave the hive

and never return owing to infections, hazardous chemicals, or an abrupt shift in habitat, this is known as colony collapse. Food supplies eventually run out, and the queen is left to fend for herself, often dying and forcing the hive to shut down completely. Some colonies have lost up to 80% of their population as a result of CCD. Many farmers are at a loss for what to do because honeybees are failing to live due to a variety of factors. The agriculture industry may suffer major implications as the population declines. Food production will decrease, resulting in a significant loss of money and affecting many socioeconomic categories. A group of Harvard University researchers hopes to provide an automated answer to this looming dilemma.

Recent Developments

When it comes to efficient pollinators, Harvard's Wyss Institute has so far reproduced most of nature's design— with some tweaks. Overall, Robert Wood and his Wyss Institute colleagues seek to create "autonomous micro-aerial vehicles capable of self-contained, self-directed flying and large-group coordination behaviour". The Robobee will be able to pollinate as well as assist in search and rescue efforts. The robot's construction design is divided into three parts: the brain, the body, and the colony. The brain will be made up of "smart" sensors that resemble the eyes and antennae of a bee. Furthermore, the brain is built to sense and respond to the environment in real time.

When combined with a small power source, the body allows the robotic insects to fly on their own. The most recent Robobee model weighs less than a tenth of a gramme and is half the size of a paper clip. To give specific aerodynamic qualities, the overall shape of the body was largely inspired by the physiology of a horse. The instrument's submillimetre anatomy and two wings allow it to flap its wings 120 times per second, allowing it to hover, steer, and lift off vertically. Pollen is collected using three-pronged feet attached to the main component of the body, with accommodations made to hold more weight. Furthermore, researchers discovered a means to strengthen the robotic insects' bodies by allowing them to switch between air and water. Developers have constructed lightweight electrolytic plates that manufacture oxyhydrogen from water using varied propulsion techniques that may overcome various physical restrictions. The oxyhydrogen is subsequently ignited by a sparker, allowing the bees to transfer from water to air as the robot takes off impulsively (Yang,2020).

The Robobee's colony feature allows it to communicate with other insect robots and act as a single entity. This is critical because bees are most efficient when they collaborate

with their colony. According to papers produced by Robert Wood's team, the ultimate goal is to develop fully independent colonies, albeit there are still issues.

Structure and functions of a Robobee

On the surface, the task appears to be practically impossible. Millions of years of evolution have moulded bees into magnificent flying machines. Their tiny bodies are capable of flyingfor hours, maintaining equilibrium during wind gusts, searching for flowers, and avoiding predators. A robot hive might be used for a lot more than just pollination (although agriculture is one potential use). Small, agile, basic, and inexpensive robots could, in fact, accomplish a greater number of tasks than a few highly proficient ones. Consider a rescue worker carrying a crate containing 1,000 Robobees, which would weigh less than a kilogramme. The Robobees might be deployed at a natural catastrophe scene to look for survivors' heat, sound, or exhaled carbon dioxide signature. The swarm will be successful if just three of the robots complete their assignment while the others fail.

A colony of robotic bees, on the other hand, faces a slew of technological problems. These small robots would be only a few centimetres long and weigh around half a gramme, less than a tenth of the weight of the world's lightest autonomous flying craft. Each bee's flight mechanism, electronic brain and vision system, and the controls that govern how that bee

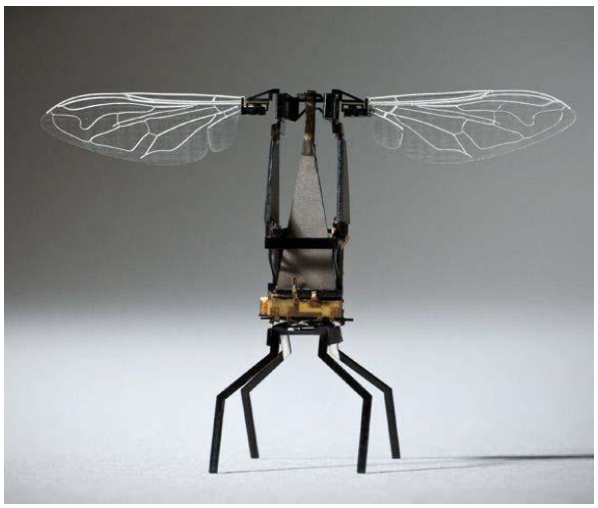

Fig 1: Different types and structure of Robobees

interacts with other members of its colony must all fit into that tiny container. These aims are becoming more attainable, thanks to recent advances in materials science, sensor technology, and computational architecture. Even if it doesn't have a complete image of the environment, a colony of thousands of Robobees will have to efficiently divide duties among people. The hive has been given the task of finding and pollinating flower fields. Individual Robobees begin by exploring various places. The new information changes where future workers will go as they return to the hive with information about where flowers are growing. More robots will be assigned to locations where there is more work to be done. Even though bee-to-bee communication is limited due to power limits, the hive-based technique allows bees to show collective intelligence.

Conclusion

It has proven increasingly difficult to "integrate a compact power source "in the quest to produce a tool as small as a honeybee. Because the robot is so small, it is more vulnerable to environmental stresses such as wind, rain, and unforeseen conditions. The only way to resolve some of the concerns outlined is to get more power. Materials science has come a long way in the last several years in attempting to overcome some of these issues, but researchers working on the project will require a long-term and stable power supply in order to give functionality for the intended purpose of pollination. Kevin Ma, a Wyss researcher, estimates that we won't see the Robobee in action for another ten years. While the effort still has a long way to go, several project critics have provided a fresh perspective on the concept in the meanwhile.

The Robobee's ultimate purpose is to help with not only pollination but also search and rescue operations and environmental monitoring. Some argue that introducing additional technology will not fix the agricultural industry's problems. Will we become complacent in our fight for environmental conservation and protection in our attempt to fix an issue that has grown as a result of several man-made variables? As colony collapse disorder continues to decimate bee populations, farmers may find themselves with little choice but to rely on Robobees to meet our urgent needs in the not-too-distant future.

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AGRIALLIS
Science for Agriculture and Allied Sector: A Monthly Magazine

Article Id
AL04131

INTERNET OF THINGS (IOT) IN AGRICULTURE: A BRIEF INTRODUCTION

Subhradip Bhattacharjee

subhradip25@gmail.com

Agronomy Section, ICAR- National Dairy Research Institute, Karnal, Haryana-132001, India

Precision agriculture has emerged as the last big thing in Agriculture. Over the last fifty years, agriculture development was focused on improving the yield as well as the financial condition of the farmer. However, deeper scientific insights have shed light on the delicate balance of ecological stability and its sophisticated relation with crop yield and humans as consumers. Precision agriculture has emerged as a resort to optimizing the inputs to minimize the impact on the environment. During the 20th century, productivity depended on three primary factors i.e., mechanization, improved seed material, and high inputs as the only means to enhance production. Although the production target was achieved with these three factors, the ill effects of soil degradation, pollution, and deforestation started getting felt in no time.

For example, currently, 70% of the total usable water is being used in agriculture, although a large part of it is laden with pesticide residues and other chemicals. Hence precision agriculture is the need of the hour to carb this chemical from entering the food system. The latest addition to precision agriculture is “Internet of Things” or “IoT”. Coined by Kevin Ashton in 1999, IoT refers collection of data from “thing” or a group of “things” and subsequently processing it with the help of artificial intelligence (machine learning) and taking an efficient and timely decision based on it. This transition has resulted conventional farming into smart farming.

IoT- key components

In IoT the data is transferred to the database in real time, where a preinstalled application takes a concise decision based on data knowledge which the program was previously trained which ultimately converts the conventional agriculture into a cyber-physical agriculture module. As compared to human intervened precision agriculture where

manpower is used to collect, analyze, and decisions making, this sensor-based fully automatic system has resulted in higher precision, lesser waste, and lesser human error. The basic architecture of IoT contains three layers; IoT platform, IoT gateway, and IoT devices.

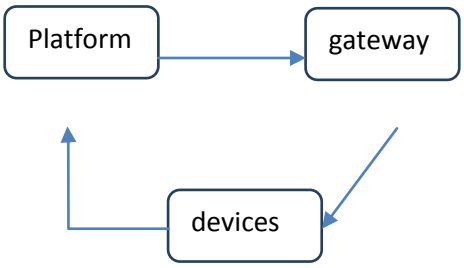

Fig1: three layers of IoT

The "Things" in the Internet of Things

Sometimes there is a lot of confusion between "device" and "things" on the basis of terminology. In general, a device is a piece of equipment that essentially has the mandatory capability of communication with sometimes added additional capability of sensing, actuation, data capture, and data processing. In the case of things, it can be an object from the physical world or from the virtual or information world which has the ability to integrate into the communication network.

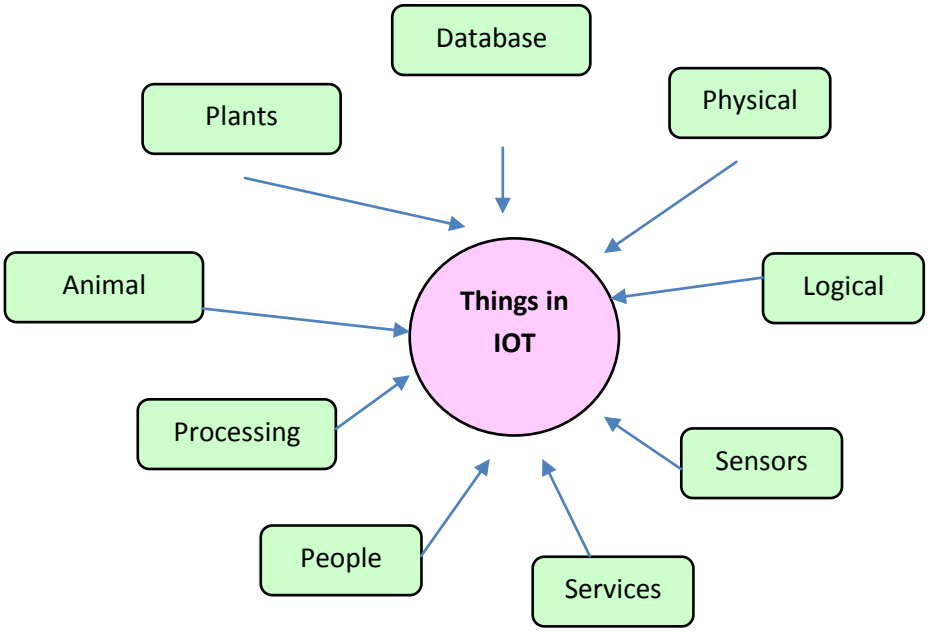

Fig 2: different states of IoTs (adapted from)

From an agricultural point of view, a few of the important things can be:

1. Location capturing sensor: the sensors which can determine elements of geographic locations.
2. Electrochemical sensors: to determine pH, EC, and other chemical and enzymatic actions
3. Photosensor: sensors that can determine the organic matter, soil properties, moisture content, etc.
4. Mechanical sensors: sensors that can determine the soil's physical properties, including penetration resistance, bulk and particle density, etc.
5. Moisture sensor: The sensors that can record the moisture content of the soil.

Architectural stages of IoT

The whole architecture of IoT is divided into four stages.

Stage 1: This is the first and primary stage and consists of sensors that receive information and data from things. The raw data is then processed and organized in the proper format for further processing.

Stage 2: In this, all the collaborative data is cleaned along with converted from analog to digital format. This stage is also known as the gateway stage as all the data has to pass through this stage.

Stage 3: The third stage is called "edge" while the process is called "edge computing". The "data or information" from the second stage isreceived through various gateways either by wired or wireless transmission. Usually, the edge receives data by wireless modes such as WiFi or similar technologies. An imperative characteristic of good architecture is to process data closer to the ends; thus, pre-analytical processing takes place here to support subsequent processing.

Stage 4: This stage is considered the final stage where the actual processing is done which is mainly based on cloud computing. Data analysis, management, archival, and management is the major element here. This stage is also responsible for decision-making. After processing the data, analysis is done according to the purpose, and valuable results are obtained which help in control, management, and decision-making.

Characteristics of IoT

The International Telecommunication Association has mentioned several characteristics of IoT which are:

1. Interconnectivity: ability to connect with global information and communication infrastructure.
2. things- related services: privacy and consistency in things-related services.
3. Heterogeneity: ability to communicate with diverse types of devices with different protocols.
4. Dynamic change: the nature of the devices to adapt and act even if the environment changes.
5. Large scale: The ability to connect with a large number of devices generating a large amount of data.
6. Maintenance-free operation: It is highly desired that IoT devices should work without human intervention hence staying maintenance-free for a long time is a desirable characteristic.

Conclusion

Being a new technology Internet of Things holds a lot of opportunities in agriculture, especially in Precision farming. The process will enable a higher boost in efficiency, resource conservation, timely management, and better profitability by using arrays of sensors, cloud computing, and artificial intelligence.

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