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Unleashing Nature's Wisdom: ITK revolutionizes IPM for Greener Agriculture

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Abstract

Indian agriculture is at least 10,000 years old. Over millennia, farmers developed innumerable practices to successfully grow crops and raise animals in the highly diversified agro ecological regions of the Indian subcontinent. The last 170 years have brought in new techniques, some useful and some harmful. The development of indigenous technical knowledge (ITK) systems, including management of natural environment, has been a matter of survival to the people who generated these systems long back (George *et al*., 2000). Most ITKs were based on the local availability of material and human resources to ensure minimal livelihoods for local people. However, with the pressing demands for higher yields to support the growing population a shift from the traditional farming system to intensive farming took place where application of synthetic pesticide has become a widely accepted method in pest control. Extensive use of high yielding varieties and agrochemicals like fertilizers and pesticides coupled with the multiple impacts of climate change has brought phenomenal changes in the crop – pest scenario.

Introduction:

The practice of using pesticides as a tool of first resort has now drifted the current IPM strategies from its ecological roots. Therefore, development of new knowledge systems with emphasis on eco-friendly approaches and new IPM strategies are felt essential to prevent new pests or the intensification of the existing ones. It has already been established that the sustainability in crop production and protection can only be achieved by developing technologies that are based on locally available inputs that are easily acceptable and cost effective. The innovative ideas of farmers in solving technical problems by local resource managements are therefore, gaining importance in recent years. Innovations based on traditional knowledge have also been emphasized by the National Innovation Foundation

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(NIF) and Department of Science & Technology, Govt. of India. The World Summit on Sustainable Development (WSSD) held at Johanesburg in South Africa during 2002 has strongly advocated the use of local technical knowledge in crop husbandry package (Anonymous, 2002).

A majority of farmers in most developing countries are small-scale farmers and their knowledge systems have never been recorded systematically in written form; hence they are not easily accessible to agricultural researchers, extension workers, and development practitioners (Warren *et al*., 1993; 1995). However, novel efforts were made in the recent past in documentation of the ITKs in publications like "Honey Bee"(a journal edited by Prof. Anil K. Gupta, IIM, Ahmedabad **);** "Inventory of Indigenous Technical Knowledge in Agriculture" – Document 2 with two supplements (a compilation of the Mission Mode Project of NATP on 'Collection, Documentation and Validation of Indigenous Technical Knowledge published by ICAR , New Delhi during 2003) and "Explored Indigenous Technical Knowledge in Pest Management" (Edr: A. K. Kanojia, R. V. Singh, O. M. Bambawale and T. P. Trivedi a publication of NCIPM, New Delhi, 2005). Most of the documented ITKs need validation before they could be recommended to the farming community.

The Vrukshayurvedic texts also provide information on various traditional pest management practices using locally available resources. A plethora of literature is available on the role of cow urine against various insect pests (Sadwarte and Sarode, 1997; Ukey and Sarode, 2003; Subedi and Vaidya, 2003; Gupta, 2005**;** Boomathi *et. al.*, 2006; Kumari and Chandla, 2010). It has been demonstrated that botanicals fermented in cow products like cow dung and cow urine could enrich microbial cultures which helped in providing plant nutrients in addition to acting as pest repellents (Prasad and Rao, 2007). Nene (2007) also indicated that utilization of organic wastes based on the methods recommended in Vrikshayurveda offers tremendous opportunity to develop novel, eco-friendly methods of manuring and plant protection through research.

In general, the ITKs are based on three categories viz., (a) Cultural practices, (b) Physical and mechanical methods and (c) Use of botanicals. Some traditional and modern knowledge in context with the above categories having relevance for adoption in IPM strategies have been reviewed and presented in the following paragraphs;

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- **Cultural practices:** Generally cultural practices enhance the "belowground biodiversity" which concurrently contribute to "aboveground biodiversity" and make the habitat more diverse for sustenance of natural enemies. The cultural practices (field sanitation; proper seed and variety selection; proper seedbed preparation; planting date; row spacing; seeding rate; fertilization; water management; crop rotation; planting of trap crops and hedge rows; companion planting; and intercropping) contribute to prevent, suppress, or eradicate pest build-up by disrupting the normal relationship between the pest and the host plant and thus make the pest less likely to survive, grow, or reproduce. Most of these practices are well experimented and practiced by the farmers. However, some strategies to grow ground cover crop and windbreaks are required to reduce dust because dust can interfere with natural enemies and may cause outbreaks of pests such as spider mites. Similarly, there is a need to avoid excess fertilization and irrigation, which can cause phloem-feeding pests such as aphids to reproduce more rapidly than natural enemies.
- **Physical or mechanical control**: It includes proper land preparation; hoeing; weeding, bagging of fruits; baits and traps; row covers; mulching; handpicking; and pruning, etc. Among the above practices traps and baits can be indigenously prepared using locally available resource for better monitoring and control of insect pests. A few examples are cited below;
- **Trapping rhinoceros beetles (RB) in coconut:** a mud pot with three quarters of it is to be filled with water and to this 250 g of powdered castor cake is added. The pot is then buried in the soil with its mouth in level with the soil. The smell of the cake attracts the beetles which fall into the water. Just 2-3 such pots in one hectare of plantation can clear beetles from the area. Slices of pine apple are also used to attract RB. In a cylindrical plastic container 2 slices of pineapple are taken and an exit hole is made to allow the rain water to drain. The trap is hung near the crown of the coconut tree. The beetles are attracted to wards the pineapple and get trapped.
- **Trapping red palm weevil (RPW) in coconut:** The mid rib of coconut leaf is cut into small pieces and crushed, place it in an earthen pot either with 1 lit of water 100 g jaggery and 10 g tobacco powder or with sugarcane molasses 2½ kg or toddy 2½ litres acetic acid 5 ml yeast 5 g. Another pot with hole at its bottom is placed over it.

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This arrangement is made at 3-4 corners of the coconut orchard to attract and trap the beetles. The mixture of jaggery, tobacco and water is to be added once in a month in case the former bait is choosen.

- **Trapping fruit flies:** Fruit fly *(Dacus dorsalis* and *D. cucurbitae)* incidence is normally seen in mango and cucurbits. A low-cost fruit fly trap to combat this insect pest can be made as follows;
  - 20 g of *Ocimum sanctum* (holy basil) leaves are crushed and the extract along with the crushed leaves are placed inside a coconut shell, which is then filled with 100 ml water. To increase the keeping quality of the extract, 0.5 g citric acid is added and the extract is then poisoned by mixing 0.5 g carbofuran 3G. The traps are suspended from mango tree branches at a rate of 4 traps per tree. The fruit flies feed on the ocimum extract and are killed.
  - Make a trap using a 2-liter disposable water bottle: Two holes at a height of 5cm from the bottom of bottle are made and for hanging the trap, use a string which is pushed through a hole drilled in the centre of the cap from inside. The attractant mixture for fruit flies is then prepared by mixing 1 cup of vinegar, 2 cups of water and 1 tablespoon of honey and shakes this well before use. Fill the trap with this mixture up to the level of holes and hang the container about 5 feet high. Flies will enter the container and fall into the attractant.
- **Traping sucking insect pests:** Bright yellow sticky traps are used for monitoring/controlling aphids, thrips and whiteflies. While, bright blue traps can exclusively be used for monitoring thrips and bright white sticky traps for flea beetles (Bissdorf, 2008). Set up sticky traps for monitoring whitefly, thrips etc. @ 10 traps per ha. Locally available empty tins can be painted yellow / coated with white grease / vaseline / castor oil. Place traps near the plants, preferably 25 cm away from the plant to ensure that the leaves will not stick to the board, but not facing direct sunlight. Position the traps at 50-75 cm above the plants. Alternatively, yellow water pan traps also proved useful for simple population counts of alate aphids based upon which insecticidal control can be initiated.
- **Trapping blister beetles:** blue containers, filled with water with little detergent are claimed to attract blister beetles.

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- **Trapping moths:** Mix 500ml of aloe extract 1 kg of castor cake and add latex as adhesive. Put this mixture in a wide opened disposable container. Place in strategic locations of the field @12 / ha (Bissdorf, 2008).
- **Control of Slugs in Kitchen Garden:** Set the rinds of grapes with a little pulp left inside with upside down (like an igloo-style) in kitchen garden. The slugs will hide underneath the grapefruit and die.

Other Mechanical control practices:

- **Attracting birds:** Erection of bird perches @ 25/ha facilitates predation of larval stages of insects.
- **Bait for Ant:** Ants often protect honeydew producing organisms such as aphids, mealybugs, and scales from attack by natural enemies. Sometimes ants move these honeydew-producing insects from plant to plant. Control of ants often leads to more effective biological control of sucking pests. The bait can be made by dissolving 1 teaspoon powdered boric acid and 10 teaspoons sugar into 2 cups of water; this mixture can then be absorbed into cotton balls which are left near ant trails.
- **Gundhi bugs in rice:** Fix dead crabs, frogs or even pieces of jackfruit (*Artocarpus heterophyllas*) to bamboo sticks and place them in rice fields before milky stage. This will attract gundhi bugs and keep them busy till the dough stage is over.
- **Rats:** Boil 10 kg of wheat seeds in water with two large pieces of the bark from the *Gliricidia* tree. Then use the boiled wheat seeds in the field or in stores where rat menace exists. Mexican farmers grind the bark or leaves, mix it with wet wheat seeds or smear it on banana slice and use it for rat killing purpose. In Panama, a mixture of cereals and ground leaves of *Gliricidia* is allowed to ferment and then this is used as a rat killer. *Gliricidia* is a rat killer as it contains coumarin which gets converted to anticoagulant dicoumerol by bacterial fermentation. This reduces the protein Prothrombin to cause death in rats due to internal bleeding
- Fruits of *Mucuna pruriencs* Back (Fam: Papilionaceae) are kept in the active rat burrows. When the rodent enters into the hole, it collides against the hairy fruits with irritating hairs and leaf the spot with irritation.

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- A mixture containing 90% sesame or g.nut or niger flour with 5% thick sugar crystals and 5% powdered bulb or tube is placed in a bowl near rat holes and when rats feed these mixtures they die within a week.
- Inserting 10 – 12 inches long fresh pieces of stem of Jatropha plant into active rat holes makes the field rat free (Kanojia, *et al*.,2005)

Use of botanicals: Botanicals are readily available than commercial products as they grow in the local environment. Reviving and modernizing age-old farmer practice through the optimization of ethno botanicals has shown that farmers are more comfortable using plant materials than commercial synthetics and those botanicals can offer a similar level of control when certain guidelines are followed to their use (Belmain, 2002).

- **Aloe (*Aloe barbadensis*; Fam: Aloeaceae) vitex (*Vitex negundo*; Fam: Verbenaceae) extract:** Soak vitex leaves (5kg) in 10 liters water. After boiling for 30 minutes cool the extract and then strain. Remove the outer part of the aloe leaves (2 kg) and grind in water to get the extract. Mix the two extracts and dilute in 50-60 liters of water to cover 0.4 ha area. Add 50-60 ml soap in the mixture and spray early in the morning or late in the afternoon. This Aloe vitex extract is reported to control armyworm, hairy caterpillar, rice leaf folder, rice stem borer, semi-looper, bacterial and fungal diseases (Bissdorf, 2008).
- **Coriander (*Coriandrum sativum*) for spider mite control:** Coiander acts as a repellent and to prepare the extract boil 200 grams of crush seeds in 1 liter of water for 10 minutes. Dilute extract with 2 liters of water. Spray early in the morning on infested plant parts to control spider mites (Bissdorf, 2008).
- **Marigold and chilli extract:** Chop 500 g of whole plant and 10 hot chilli pods; Soak them overnight in 15 liters of water. Dilute the filtrate with water at 1:2 ratios and add soap @ 1tsp per liter of extract. This controls most agricultural pests (Bissdorf, 2008).
- **Turmeric (*Curcuma domestica*)**: Soak shredded rhizome (20g) in 200ml cow urine. Dilute the mixture with 2-3 liters of water and add soap (8-12 ml) and spray. The extract controls aphids, caterpillars, red spider mites and powdery mildew (Bissdorf, 2008).

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- **Indian privet tree (*Vitex negundo*; Verbenaceae):** Soak 2kg vitex leaves overnight in 5 liters of water and boil the mixture for 30 minutes. Add 10 liters of water and soap (10ml) and spray. This controls DBM, hairy caterpillars, rice leaf folder, rice stem borer and semilooper (Bissdorf, 2008).
- **Neem leaf extract:** Pound 1kg neem leaves and place it in a pot with 2liters of water. Cover the mouth with cloth and leave it as such for 3 days. Dilute the extract at 1:9 with water and add 100 ml of soap before spraying. This controls aphids, grasshoppers, leaf hoppers, plant hoppers scales thrips weevils and beetles (Bissdorf, 2008).
- ***Calotropis gigantean:*** Leaves are preserved in big earthen pot filled with water for two weeks. The water is applied @ 0.5 l / tree to control termites. The leaves are replaced after 2 months.

Other pest control formulations based on ITK:

- **Fermented curd water** – In some parts of central India fermented curd water (butter milk) is used for the management of white fly, jassids aphids etc.
- **Cow milk**: Cow's milk was reported to acts as an excellent sticker and spreader due to presence of casein protein has excellent spreader and sticker property. It can be used @ 10% aqueous suspension for effectively controlling powdery mildew. Milk sprays induced systematically acquired resistance in chilli against leaf curl, a viral disease (Arun Kumar *et al.,* 2002).
- **Cow urine and dung:** Cow urine diluted with water in ratio of 1: 20 is not only effective in the management of pathogens and insects, but also acts as a growth promoter of crops.
- Cow urine have been found effective against mealy bugs, thrips and mites (Peries, 1989) and against post flowering insect pests of cowpea (Oparaeke, 2003).
- Crush 5 kg neem leaves in water, add 5lit cow urine and 2 kg cow dung ferment for 24 hrs with intermittent stirring, filter the extract and dilute it in 100 lit of water for spraying over one acre. This extract is useful against sucking pests and mealy bugs.
- In brinjal, application of cow urine10% starch 1% (Pradhan, 2011) either alone or alternatively with chlorantraniliprole 18.5 SC (Sakhinetipalli, 2012) was found to be cost effective.

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Botanicals fermented in cow urine/cow dung:

The cow urine decoctions of botanicals have been reported as effective against the various insect pests without noticeable detrimental effect on their natural enemies (Poonam, 2003; Gupta, 2005).

- Cow urine 5% with neem seed kernel extract 5% and cow dung 5% showed anti-feedent and anti-ovipositional effects against *Helicoverpa armigera* (Sadawarte and Sarode, 1997; Boomathi *et al.,* 2006).
- Among 14 cow urine mixed botanical extracts tested *Lantana camara* Linn. and *Vitex trifolia* were reported effective against aphid, *Lipaphis erysimi* (Shreth, *et al*., 2009).
- Crude extract of *Datura alba* (20%) cow urine (20%) was effective against stem borer and leaf folder in Basmati rice (Aswal *et al.,* 2010).
- Barapatre and Lingappa (2003) also documented the effectiveness of cow urine along with various botanicals *viz*., NSKE, *Pongamia*, *Vitex* and *Aloe vera* against *S. litura* and *H. armigera* in groundnut and chickpea, respectively
- Combination of cow urine with NSKE and *Vitex* reduced the shoot fly infestation in sorghum (Vijayalaxmi, *et al*., 1996; Mudigourdra, *et al*., 2009).
- Cow urine fermented karanj leaves (10%) / neem leaves (10%) were ideal in respect of marketable fruit yield (135.5-141.7 q / ha) and benefit: cost ratio (38.20:1 – 42.68:1) despite of their ineffectiveness against the shoot and fruit borer in brinjal (Shailaja, *et al*., 2012).

Ash:

A thick layer of ash is either spread on the soil around plants or sprinkled on foliage to protect it against a variety of pests. Besides acting as a physical poison ash on crop foliage interferes in the chemical signals emanating from the host plants thus obstructing the initial host location by pests. Ashes from burnt palm frond and bunches have been traditionally used in the eastern parts of Nigeria to dust the leaves of okra to protect against leaf eating beetles, *Podagrica* spp. (Oparaeke, *et al*., 2006). Application of ash @50kg/ha kerosene5% and spinosad 45SC generated maximum benefit cost ratio of 4.8:1in brinjal (Sakhinetipalli, 2012).

Kerosene:

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It is readily available with the farmers and can be used with soap instantly to suppress the insect pests at the beginning of outbreak situation and subsequently the desired/recommended strategies may be followed. The use of Kerosene-soap-water emulsion has earlier been reported as a contact insecticide for piercing and sucking insects (Jex-Blake, 1950). Similarly, the usefulness of this emulsion against scale insects, bugs, mites, aphids and leaf miners has been documented by Van der Werf (1985). Oparaeke, *et al.* (2006) reported the effectiveness of SABRUKA (a mixture of soap, water and kerosene) against insect pests of cowpea in the northern Guinea Savanna. Kerosene exhibits phytotoxicity at higher concentrations and therefore, its use as foliar spray should be restricted up to 1 or 2%. Prepare a 4 lit. stock solution of soap kerosene mixture in the below given proportion; 3.5 lit.Water 48 g soap (1.2%) 500 ml kerosene (12.5%). Before spraying dilute 250 ml of this mixture with 4 liters of water.

Oils may also repel some pests, but the problem of phytotoxicity cannot be ignored. Visible leaf damage, or more subtly reduction in yield could be possible. Bi-weekly oil applications reduced whitefly counts on tomato leaves by two thirds, but yield on the oil-treated plants was also reduced compared to untreated plants (Stansly *et al.,* 2002). Five oil sprays controlled powdery mildew in grapes but reduced sugar levels (Northover, 2002).

Conclusion:

Indian farming, which is going through a transition phase, is slowly but surely adopting the ways and means of pest management for sustainable agriculture (Dhandapani *et al.*, 2003). Adoption of ITK based crop protection measures as an alternative to pesticides might help in restoring the biodiversity of natural enemies, but as IPM is a knowledge-based and farmer driven approach, education of farmers on alternatives to pesticides must be given a priority.

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