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GOOD ORCHARD MANAGEMENT PRACTICES IN *KHASI* MANDARIN (*CITRUS RETICULATA* BLANCO)

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ABSTRACT

Khasi Mandarin fruit (Citrus reticulata Blanco) is one of the most important commercial fruit crops of the northeastern hill region of India. The fruit is unique in taste, aroma, and flavour, thus considered one of the best mandarins. The fruits have several uses including food industries, pharmaceutical industries, etc with the stored house of bioactive compounds for health benefits. Given these, good orchard management practices are very essential for higher yield and quality production of Khasi mandarin fruits. This will indirectly improve the economics of the orchardist.

INTRODUCTION

Khasi Mandarin fruit (Citrus reticulata Blanco) locally known as Sohñiamtra is the most important commercial fruit crop of the north-eastern hill region of India. The fruits are preferred due to their unique taste, aroma and flavour. In India, the famous mandarin fruits are Nagpur Mandarin, Coorg Mandarin, Khasi Mandarin, Darjeeling Mandarin, and Kinnow mandarin. Khasi mandarin is an ecotype of the northeastern hill region, India with special reference to the Khasi Hills of Meghalaya, India (Figure 1). Therefore, there is so much variability among Khasi Mandarin in terms of plant growth, yield, and quality characteristics.

Figure 1. Ripened fruits of *Khasi* mandarin

AREA AND PRODUCTION OF MANDARIN FRUITS

Among fruits, citrus fruits are cultivated in an area of about 1003 thousand hectares and production of 12546 thousand MT in the country which accounts for 13% of total fruit production. The most important commercial citrus species in India is the mandarin orange which occupies 428 thousand ha with a production of 5101 thousand MT (NHB, 2018). The total area under citrus cultivation in the northeast hill region was 107.91 ha with 677.59 metric tonnes in production. Whereas, Mandarin occupies an area of 70.28 ha with a production of 424.52 metric tonnes (figure 2).

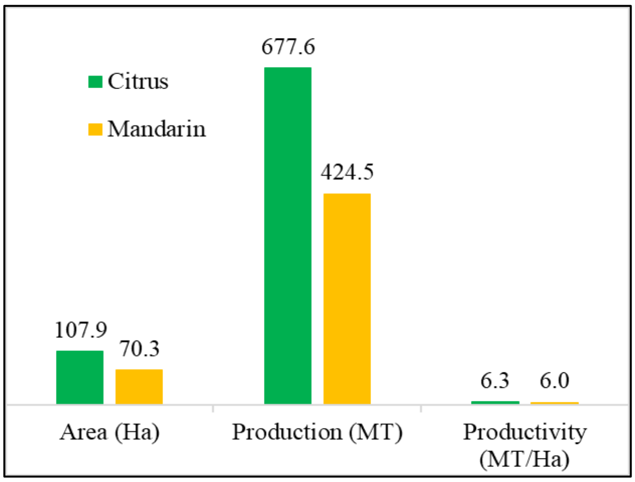

Figure 2. Area, production and productivity of citrus and Mandarin fruits in the north-eastern hill region, India

It is indicated that Mandarin fruit accounts for 65.13% and 62.65% of the total area and production, respectively under citrus fruits. The productivity of citrus fruits was 6.3 MT Ha-1 and that of Mandarin 6.0 MT ha^{-1} in the region. In Meghalaya, *Khasi* mandarin fruits account for about 88.7% and 90.2% of the total cultivated area (10.47 thousand hectares) and production (50.2 thousand MT) under citrus fruits (NHB, 2018).

UTILIZATION

The fruits of mandarin are known to have rich sources of several nutrients, vitamins and antioxidants which possess health-beneficial compounds (Table 1). Citrus fruits are considered a valuable source of soluble and insoluble fiber that help remove the toxic effects in the body (Pragasam *et al*., 2013).

Table 1. Chemical composition of *Citrus reticulata* (per 100g of edible portion)

Component	Moisture (g)	Protein (g)	Fat (g)	Carbohy-drates(g)	Minerals (g)	Calcium (mg)	Phos-phorous	Iron (mg)	Thiamine (mg)	Vitamin C (mg)	Caro-tene, (µg)
Value	87.8	0.9	0.3	10.6	0.4	50	20	0.1	40	68	350

Source: Waleed, (2019)

GENETIC DIVERSITY OF CITRUS

The genus Citrus belongs to the Rutaceae family is economically important and is known throughout the world for its juice and pulp. According to Tanaka (1977), this genus includes 162 species and is grown in tropical and subtropical parts of the world. In India, there are 30 Citrus species (Singh and Chadha 1993) of which at least nine species are available throughout India, while, the northeastern Himalayan region contains 23 species, 1 subspecies, 7 probable natural hybrids, and 68 varieties of citrus (Bhattacharya and Dutta, 1956; Sharma *et al*., 2004). Thus, the region is considered the centre of origin of several Citrus species as evidenced by the natural undisturbed populations of the Citrus gene pool.

SOIL

Well-drained medium-deep soil is to be selected for the orchard and is considered favourable with a soil pH of 5.5 to 6.5.

AGRO-CLIMATIC CONDITIONS

Khasi Mandarin thrives well in sub-tropical to semi-temperate climates up to 1000 m asl with high humidity, warm summer and mild winter for successful growth.

PROPAGATION

Khasi Mandarin were propagated through seeds, budding and wedge grafting.

1. **Seed:** Immediately after extraction (within 1 week) seeds were sown in the nursery to a depth of 1.5-2 cm at a 10 x 5 cm distance. At 4-6 leaf stages, seedlings were replanted in secondary bed or polythene bags of size 5x8'' (containing equal part of soil, sand and FYM) in polyhouse/low-cost polyhouse for speedy and uniform growth. Seedlings selected for planting should be strong, healthy and free from pests and diseases and be of uniform growth and about 60-90 cm in height. Rootstocks were also raised as the above-mentioned technique.

2. **Budding**: Budding was performed during the month of February-March or in July-August by "T" - Budding method. Rough lemon and Rangpur lime were used as rootstock.

3. **Wedge grafting:** Wedge grafting was performed during the month of February or in July – August by wedge grafting method. Previous season 3-4 months old shoot of 2-4 mm thickness with 3-4 healthy buds of 8 to 10 cm long round shape were selected as scion stick. Rough lemon and Rangpur lime (90-120 days) were used as rootstock.

PLANTING SYSTEM

1) **Pit preparation:** The size of the pit is kept at 0.75 x 0.75 x 0.75 m and the pit is refilled with upper 30 cm soil along with 15-20 kg FYM, 100g urea, 100 g MOP, 300 g SSP and 50 g chlorpyriphos dust or granule. The pits are filled about 15 cm above the ground level.

2) **Spacing:** In plain areas, orchards can be established in a square system (5x5 m). Whereas, on hill slopes, contour bunds can be made at a distance of 5-6 m depending upon the gradient and then half-moon terraces can be made in between two contour bunds with required spacing.

3) **Planting time:** The best time is June to August. If there is no rain after planting, light irrigation should be given. Bud/graft union should be kept at least 15 cm above ground level.

MANURE AND FERTILIZER

Depending upon the age of the tree, the following manure and fertilizer schedule is followed:

Type of manure	**Time of application**	Age of tree (Year)					
		I	**II**	**III**	**IV**	**V**	**VI**
FYM, kg	Feb-March	-	5	10	15	20	25
Urea, g	March	100	150	200	250	300	350
SSP, g	March	100	200	300	400	500	600
MOP, g	March	50	100	150	200	250	300
Lime, kg	Feb.	-	1	2	3	4	5

Repeat the same dose of urea, SSP and MOP from June-July and again in September-October. Therefore, the requirements of grown-up trees may be N-480g, P_2O_5-290g and K_2O-540g along with 25kg FYM per tree per year. The fertilizers are applied around the basin under the canopy of the tree, 20-25 cm away from the main stem. Besides, 2-3 spraying of Zinc Sulphate (0.4%) + Magnesium Sulphate (0.2%) + Copper Sulphate (0.3%) or Multiplex @ 2.5ml/litre of water should be given during flushing period.

IRRIGATION

Irrigations are to be given only during dry periods, the first being at planting time, subsequent irrigations can be given at 15-20 days intervals from December to March if possible.

INTERCULTURAL OPERATION

Weeding should be done frequently at a monthly interval, mulching with paddy straw or black polythene can also use to control weeds.

INTERCROPPING

Additional income can be obtained by growing suitable intercrops such as French bean, rice bean, cowpea, black gram and other vegetable crops from mandarin orchards during the pre-bearing stage (1-5 years).

PHYSIOLOGICAL DISORDERS

1) **Fruit drop:** Control of fruit drop can be achieved by spraying with 2,4-D or GA3 @ 15 (mg/L) + Urea (10 g/L) + Benomyl (1g/L) in April, May and September or Spraying of Planofix @ 1 ml/5 L of water in the month of March-April and August-September also minimise the fruit drop.
2) **Granulation:** Application of 2-3 sprays of NAA (300 ppm) during August, September and October may reduce the incidence by 50%. Foliar application of GA_3 (15 ppm) followed by NAA 300 ppm during October and November was also effective.

DISEASES & MANAGEMENT

1) **Damping off:** Cotyledons of newly emerged seedlings rotted near the ground. Spraying and soil drenching with Bavistin @ 2.5g/litre of water effectively controlled the disease.
2) **Powdery mildew:** A whitish powdery growth is visible on young leaves and green parts. Spraying of Sulfex @ 2.5 g/litre of water during the flush period is recommended to control the disease.
3) **Scab:** The disease is identified by the corky lesion on fruits, leaves and young branches. To control the scab spraying of Bavistin @ 2g/litre of water in April, June and September are recommended.
4) **Twig blight:** The plant exhibits drying of twigs and small branches from the growing tip. The affected portion should be cut and pasted with Bordeaux paste. Spraying with 1% Bordeaux mixture or Copper oxychloride @ 2.5 g/L was found effective.

5) **Phytophthora rot:** The first indication of the disease is exudation of gum from the bark of the stem. The bark cracks open and in the later stage dries up. Drenching of root with 1% potassium permanganate solution followed by a 1% Bordeaux mixture may save the plant from declining.

INSECT – PEST MANAGEMENT

1) **Leaf miner (*Phyllocnistis citrella*):** Caterpillars feed on newly emerged leaf tissues forming zigzag shrinking streak-like galleries. Pruning the affected parts during winter. Spray of Nimbecidine (2%) / Methyl Demeton (0.03%) during February-March (at the emergence of new leaves). Soil application of Phorate 10 G (2.5 kg a.i./ha) one day before planting is effective to reduce the larval population of this insect.

2) **Aphid** (*Toxoptera citricida*): Nymphs and adults suck the sap from newly emerged leaves, tender parts and flowers. Spray Malathion (0.03%) may effectively control this pest.

3) **Mealy bug (*Planococcus citri*):** The nymphs and adults suck the sap from plants. Avoid host plants such as cotton, bajra, maize, berseem, okra and creeper-like vegetables in the orchards. Avoid the branches of trees touching the ground. Destroy ant nests in the orchards. Drench spray of 1875 ml Durmet/Dursban/Coroban 20 EC (chlorpyriphos) in 500 litres of water first on the appearance of the pest and repeat the spray 15 days after the first spray. The application of dimethoate (Rogor) @ 1.5 ml/L of water can effectively control these insects.

4) **Lemon butterfly** (*Papilio demoleus*): Caterpillars feed on leaves, defoliate the plants, very serious in the nursery. It can be controlled easily by hand picking and killing of larvae as well as spraying chlorpyriphos @ 2 ml/L.

5) **Citrus thrips** (*Scirtothrips citri*): It causes damage to flowers, leaves and young as well as grown-up fruits by lacerating, rasping and sucking the cell sap. Spray 1000 ml Metasystox 25 EC (oxydemeton methyl) or 1000 ml Fosmite 50 EC (ethion) twice in 500 litres of water. The first spray is given in mid-March and the second in mid-April.

6) **Citrus Trunk borer** (*Inderbela* sp.): Grubs bore and feed on the bark, making tunnels inside the trunk. To kill the trunk borer grubs, clean the bored hole of the infested plant with iron wire and insert a cotton swab soaked in dichlorvos/petrol or inject 5 ml of dichlorvos (2.5 ml/ litre) or petrol and plug with mud. Collection and destruction of trunk borer adults

during May-June by shaking the branches 2-3 times at 10 days intervals may also help in controlling the pest population.

HARVESTING AND YIELD

Fruits should be harvested when they attain full size and develop attractive colour with optimum sugar. Fruits are ready for harvesting during the month of November-December. From a 6-year-old tree, about 40-50 fruits may be harvested.

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POTASSIUM FOR HIGHER GRAIN YIELD AND FODDER QUALITY OF MAIZE CROP

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ABSTRACT

Potassium is an important macronutrient which plays a significant role in plant growth and development. The deficiency of potassium which appears first on older leaves results in stunting and poor growth of the maize crop and ultimately reduces the crop grain as well as fodder yield. In maize grown for grain purpose, recommended dose of potassium improve the grain yield, nutrient concentration, protein content and economic returns. In fodder maize application of a recommended dose of potassium improve the grain as well as fodder quality and economic returns. Hence, the application of potassium is a good way to improve the yield, and quality of maize crops and a good way to achieve good profit for the maize-growing farmers.

INTRODUCTION

Agriculture development always remained a ray of hope which provided food, feed and fodder for both humans and animals. Among various discoveries, nitrogen fixation, the green revolution, the conceptualization of principles of genetics, combine harvester, Archimedes' screw and refrigeration helped tremendously in achieving the green revolution around the world. Over the century, the advancement in agricultural technologies leading the way for higher production and quality produce. Agriculture moved from subsistence farming to intensive farming. After the green revolution, the decline in factor productivity was observed due to intensive agricultural practices. The imbalanced nutrient management practices lead to a decline in factor productivity. Among macronutrients, potassium is the most neglected nutrient regarding application to food and fodder crops.

ROLE OF POTASSIUM IN THE CROP?

- Potassium regulates photosynthesis in plants by governing the opening and closing of the stomata.
- Potassium helps in the activation of various enzymes in plants which generates ATP requires to provide the energy to carry out various chemical and physiological processes in the plants.
- Potassium plays a significant role in the osmoregulation of water and other salts in plant cells and tissues.
- Potassium contributes a significant part to starch synthesis and facilitates protein synthesis in plants.

A field view of potassium applied maize crop

DEFICIENCY SYMPTOMS OF POTASSIUM IN MAIZE

Being a mobile element, deficiency, of potassium first appears on older (lower) leaves. In general potassium deficiency appears on leaves as brown scorching with curling of leaf tips as well as chlorosis between leaf veins. Purple spots may also appear on the underside of the leaf. Potassium deficiency may induce stunted plant growth, and root development and also reduce seed and fruit development. Deficient plants may be more prone to frost damage and disease, and their symptoms can often be confused with wind scorch or drought.

SOURCES OF POTASSIUM FOR PLANTS

Potassium Chloride: It is the most common source of potassium which carries 60-62% K_2O on per kg basis for most food crops.

Potassium sulfate: It can be used to supply sulfur along with potassium to the crop. It is suitable for both food and tuber crops. Potassium sulfate carries 50% K_2O on per kg basis for most of the food crops.

Farmyard Manure: The K content of farmyard manure varies with animal type, feed ration, storage and preparatory techniques. Generally, the K content in farmyard manure varies from 0.5 to 1.0 %.

TIME AND METHODS OF POTASSIUM APPLICATION IN MAIZE

For any crop, the time and method of nutrient application are very important. Generally, potassium is applied as a basal dose in maize crops at the time of sowing either by broadcasting or band placement. In some areas, potassium is also applied as foliar spray @ 2% to correct the potassium deficiency in the standing maize crop.

EXPERIMENTAL RESEARCH FINDINGS ON POTASSIUM APPLICATION IN MAIZE

A) Grain Maize:

Kumar *et al*., (2015) experimented on maize crops at IARI New Delhi and showed that the application of potassium results in increased maize grain yield with an increased level of potassium fertilizer doses. The application of inorganic potassic fertilizers resulted in higher zinc and iron content as well as crude protein content in the grain. The treatment applied with a recommended dose of potassium (RDK) @60 kg/ha recorded the highest B: C ratio of 1.05 Rs/ha.

Table 1. Effect of the Recommended dose of potassium on yield, quality and B:C ratio of fodder maize crop

Parameter	No K application	RDK applied @60 kg /ha
Green fodder Yield (t ha^{-1})	2.21	3.6
Stover Yield (t ha^{-1})	4.9	5.7
Crude protein content (%)	9.7	10.7
Zn Content (ppm)	21.3	26.3
Fe Content (ppm)	44.7	48.3
B:C ratio	0.62	1.05

B) Fodder Maize:

Baljeet *et al.*, (2020) showed that the application of potassium results in increased green and dry fodder yield of maize. The application of inorganic potassic fertilizers resulted in higher zinc and iron content in the fodder on a dry weight basis. Application of RDK @40kg/ha also recorded higher crude protein content, total ash content and ether extract content. The treatment applied with a recommended dose of potassium (RDK) @40 kg/ha recorded the highest B: C ratio of 2.19 Rs/ha.

Table 2. Effect of the Recommended dose of potassium on yield and quality of fodder maize crop

Parameter	No K application	RDK applied @40 kg /ha
Green fodder Yield (t ha^{-1})	30.5	44.7
Dry matter Yield (t ha^{-1})	5.9	8.2
Zn Content (ppm)	16.5	22.1
Fe Content (ppm)	90.0	101.4
Crude protein content (%)	7.3	8.7
Ether extract (%)	1.64	2.0
Total Ash (%)	8.3	9.6
B:C ratio	1.26	2.19

CONCLUSION

Potassium is an important macronutrient which plays a significant role in plant growth and development. The deficiency of potassium which appears first on older leaves results in stunting and poor growth of the maize crop and ultimately reduces the crop grain as well as fodder yield. In maize grown for grain purpose, recommended dose of potassium improve the grain yield, nutrient concentration, protein content and economic returns. In fodder maize application of a recommended dose of potassium improve the grain as well as fodder quality and economic returns. Hence, the application of potassium is a good way to improve the yield, and quality of maize crops and a good way to achieve good profit for the maize-growing farmers.

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SCIENTIFIC WEED MANAGEMENT FOR HIGHER PRODUCTION IN SUGARCANE

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ABSTRACT

Sugarcane's slow-growing nature during the initial growth stage and long duration provide ample opportunity for weeds to grow profusely with minimal competition from main crops. Weed problems cause serious damage to sugarcane crops by causing high pressure by utilizing nutrient and water input resources. The initial 120 days in sugarcane can be considered the critical period for crop-weed competition. In general, for most annual crops first 30-40 days weed-free period is very important. Adoption of integrated weed management practices may help to reduce weed competition without creating an ecological disturbance.

INTRODUCTION

Sugarcane is a long-duration crop which takes a long time for germination and the crop faces tough competition with weeds between 60 to 120 days of its planting which causes a heavy reduction in cane yield. So, weeding around 100-120 days or 120-150 days after planting cane is highly necessary for higher yield. There are many annual, perennial, narrow leaf weeds, broad leaf weeds, sedges, and binding weeds that affect sugarcane crops profusely. Sugarcane being a long duration and widely spaced (60 to 120 cm row distance) crop provides an ample opportunity for several weeds to grow in vacant space, right from planting to harvesting. In sugarcane, weeds have been estimated to cause a 12 to 72 % reduction in cane yield depending upon the severity of infestation.

The nature of weed problem in sugarcane cultivation is quite different from other field crops because of the following reasons:

- Sugarcane is planted with relatively wider row spacing.

- Initial slow growth and wider row spacing provide ample opportunity for weeds to occupy the vacant spaces between rows and offer serious crop-weed competition.
- The sugarcane growth is very slow in the initial stages. It takes about 30 - 45 days to complete germination and another 60-75 days for developing a full canopy cover
- The crop is grown under abundant water and nutrient supply conditions
- In the ratoon crop, very little preparatory tillage is taken up hence weeds that have established in the plant crop tend to flourish well.
- The critical period of crop-weed competition has been recorded to be 60-120 days after planting in spring cane and 150 days in autumn cane.
- Bermuda grass (*Cynodon dactylon*) cogon grass (*Imperata cylindrica*) and other graminaceous weeds are known to be alternate hosts to Ratoon Stunting Disease (RSD) of sugarcane.
- Twining weeds like *Ipomoea* spp. are becoming a problem in many sugarcane growing areas, escalating the cost of cultivation besides decreasing cane yields. The twining weeds also cause serious harvesting problems.

In North India, the predominant weed are *Cyconodon dactylon, Cyperus rotundus, Dactylocternium aegyptium Echinochloa* spp, *Saccharum* sp among narrow-leaved and *Chenopodium album, Solanum nigrum, Convolvulus arvensis Trianthema* sp. *Digera arvensis, Anagallis arvensis*, *Fumania* sp. *Portulaca oleracea*e L. etc. among broad-leaved weeds.

IMPORTANT WEEDS OF SUGARCANE

Convolvulus arvensis

Hispida spp.

Trianthema monogyna

Cyprus rotundus

Launia Spp.

Sorghum halepense

Amaranthus viridis

Sugarcane crop with weed infestation

PERIOD OF WEED GROWTH AND CRITICAL PERIOD OF CROP-WEED COMPETITION

Weeds interfere with crops at any time they are present in the crop. The period at which maximum crop weed competition occurs is called as critical period which is the shortest time in the ontogeny of the crop when weeding results in the highest economic returns. As a thumb rule, the first ¼ - 1/3 of the growing period in many crops is a critical period. The duration of a sugarcane crop is 12-16 months. So, in sugarcane, the initial 120 days can be considered as a critical period for crop-weed competition. In general for most annual crops first 30-40 days a weed-free period is very important. In a situation, where weeds germinate late, as in the case of sugarcane, the late-stage weeding is also more useful as early weeding. So, weeding around 100-120 days or 120-150 days after planting cane (variety dependent) is as important as early weeding done in the initial crop growing period (30-40 days), as weed seeds keep on germinating because of wide row spacing and sunlight reaching in the exposed inter-row spaces (until full crop canopy development). Subsequently, frequent irrigations, heavy fertilizer dose and high temperature induce many new flushes of weeds. Bermuda grass (*Cynodon dactylon*), nutsedge and several species of morning glories (Ipomoea spp., convolvulus spp. etc) pose special weed problems in sugarcane in different areas.

WHAT IS INTEGRATED WEED MANAGEMENT

Increased world population will demand more food production, which can only be achieved by increasing crop yields and applying a sustainable approach, i.e. more production with rational use of available resources, which also implies responsible use of land and water and enhanced food diversity. Efforts are needed to reduce crop losses due to pests through the implementation of Integrated Pest Management (IPM) (resistant crop varieties, rational use of pesticides, biocontrol and better cultural practices) without harmful side effects. Among the pests, weeds are considered an important biotic constraint to food production. Their competition with crops reduces agricultural output (quantity and quality) and increases external costs by spreading them across farm boundaries. It is also a major constraint to increased farmers' productivity, particularly in developing countries.

ECOLOGICAL IMPORTANCE OF IWM

In most ecosystems, herbicides have become one of the most important components in weed control. There are two reasons to explain the increased use of herbicides, the first being the widespread adoption of high-yielding varieties which created economic incentives for farmers to reduce weed infestation; and the second is the availability of cheap herbicides. Because of the availability of cheap herbicides, it is expected that herbicide usage will continue to increase, both in developed countries and even in developing countries. However, this does not indicate a lack of importance for hand-weeding. Manual weeding is still the dominant weed control method in many parts of Asia since management options for weed control are limited under diverse agroecological conditions.

However, intensive and repeated application of this type of herbicide has resulted in several negative effects, as follows:

- Evolving resistant weeds.
- Residual effects on the following crops

All these factors may well provide sufficient reason to attract public concern and anxiety regarding the negative effects of herbicides that might originate from intensive herbicide application in the environment. In this regard, an alternative to such a heavy dependence on herbicide is needed. Such an alternative might be found in the use of integrated weed management, which can reduce herbicide use in different cropping systems.

Weeds exist in many different forms and with different life spans; there are annual, biennial, and perennial weeds. Weeds are not always bad, and low density will result in no or small yield losses. Heavy manifestations of weeds, or establishment of perennial weeds, can result in large yield losses or can even take land out of production until the weeds are controlled. Weeds can also reduce yield quality and can be toxic when ingested by animals or humans. Weeds can also cause environmental damage and loss of agricultural biodiversity, by competing for inputs.

INTEGRATED WEED MANAGEMENT AIMS AT

PREVENTING WEEDS FROM SPREADING BY:

- Cleaning farm machinery and vehicles before transporting, to avoid the risk of spreading weeds.
- Using only well-stored and rotted manure (4-5 months), possibly improve decomposition. Make sure that soil disturbances are immediately reseeded.
- When possible, practice weed control on all aspects of the farm, including irrigation canals, drainage ditches, fence lines, stockyards, and farm roads.
- Improving knowledge of the identification and effects of different types of weeds.

- Making control decisions based on full knowledge of potential damage, cost of control methods, and the environmental impact of the control strategy.
- Using combinations of (preferably biological) weed control strategies to reduce the weed populations, can include winter cover crops, mulching, crop rotations, natural competition, proper seedbed preparation, proper fertilizer application, stimulating bio-control by insects, hand weeding, and try to avoid herbicide application whenever possible.
- Evaluate and monitor the effectiveness and (environmental) effects of control strategies.

INTEGRATED WEED MANAGEMENT IN SUGARCANE

- Weed control could be achieved through crop rotations, crop competition, mulching, clean cultivation, trap cropping, etc.
- Crop rotation practices help in breaking the weed chain and thus help in the destruction of the particular type of weeds. For example, growing paddy in rotation needs a puddled soil condition by which effective reduction of monocot weeds is possible, which are otherwise difficult to control. Several twining weeds can be controlled by growing paddy in rotation.
- Intercropping also provides another means of reducing the weed population. Fast growing short duration intercrops are useful for this purpose. Mulching using sugarcane trash helps in suppressing weeds substantially.
- Agronomic practices could be used to reduce the chances of new weed introduction and further spread of weeds.
- Perennial weeds are difficult to manage such weeds can be managed by digging patches of weeds, collection and destruction of underground parts with the use of translocated herbicides like glyphosate.
- Moisture management is one of the important steps in the integrated weed management process. Adopt drip irrigation to minimize weed population.
- Summer deep ploughing exposes the fields to the heat of the sun for three to four weeks or more periods help in destroying perennial weeds.
- Optimum plant population may be maintained using good quality planting material and proper methods of planting.
- Crop rotation must be followed like cotton, soybean, green gram, cowpea, sun hemp, dhaincha or groundnut, etc.

- Water channels, bunds and surrounding areas must be free from weeds for avoiding the spread of weeds in the field.
- Use well-decomposed FYM or compost for minimizing the spread of weeds in the field. Band placement of recommended dose of fertilizer at the proper time for better crop growth and suppressing weeds.
- Adopt intercropping of the suitable crop as per planting season.
- Atrazine or simazine @ 2 - 2.5 kg a.i./ha as pre-emergence spray about 3 to 4 days after planting in the plant cane and after completion of basic requirements of ratoon management about 3 to 4 days after giving irrigation in the ratoon crop.
- It is required to give one hand weeding after 30 to 40 days after planting depending upon weed intensity.
- Application of Atrazine @ 1.0 -1.25 kg a.i/ha with 1000 liters of water after planting under moist condition-controlled weeds. To manage broad-leaved weeds, application of 2,4-D Sodium Salt @ 1.0 kg a.i/ha with 600 litres of water can be done up to 60 days after planting
- Application of trash mulching @ 10 t/ha in plant cane/ratoon to reduce weed growth and high productivity.

In case of intercropping of sugarcane with vegetables like cabbage, okra, potato, oilseeds or pulse crops use Fluchloralin (Basalin) @ 1 to 1.5 kg a.i/ha as a pre-emergence spray. One hand weeding if required after one month after planting.

CONCLUSION

Sugarcane is long duration cash crop. Poor weed control practices may result in drastic yield reduction and cause heavy economic losses for sugarcane farmers. Heavy dependency only on chemicals for weed control may also reduce the soil's biotic life due to residual effects. Adoption of integrated weed management is more appropriate for higher yield of sugarcane and maintaining the ecological balance too.

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GLIMPSE OF AN INTEGRATED FARMING SYSTEM

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ABSTRACT

More than 80% of farmers in India are marginal and small with a farm holding less than 2 ha. Due to power economic conditions, these farmers are unable to invest in high-end agricultural technologies to increase production and meet their daily necessities. Adoption of an integrated farming system by selecting the appropriate combination of agricultural enterprises based on the specific needs and suitability to the specific agro-climatic conditions, and socio-economic situation of the farmer is essential for augmenting the income of a farm, increasing productivity, profitability, sustainability and family labour employment.

INTRODUCTION

Agriculture and allied sector have a vital role in ensuring food security, nutritional security, reducing poverty and sustaining the growth of its burgeoning population in India. More than 80% of farmers in India are marginal and small with a farm holding less than 2 ha. Due to power economic conditions, these farmers are unable to invest in high-end agricultural technologies to increase production and meet their daily necessities. Further, widespread occurrence of side-effects of the green revolution viz; declining factor productivity, unemployment during the off-season, reduction in nutrient status of soil, and declining operational land holdings pose serious challenges to sustainability and profitability of existing farming systems, especially to marginal and small households. To make farming more economically viable, and environmentally safe and to improve sustainability a holistic approach

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is requisite to be made. In this situation, an integrated effort must be made to address all emerging livelihood issues. The integrated farming system is a powerful tool in this situation to improve the livelihood of small and marginal farmers on a sustainable basis.

INTEGRATED FARMING SYSTEM

According to Singh and Ratan (2009), an integrated farming system can be defined as an integrated set of elements/ components and activities that farmers perform on their farms under their resources and circumstances to maximize productivity and net farm income on a sustainable basis. The integrated farming system introduces a change in the farming techniques for maximum production in the cropping pattern and takes care of optimal utilization of resources. In the integrated farming system, farm wastes are better recycled for productive purposes. The activities of an integrated farming system are focused on a few selected, interdependent, interrelated and often interlinking production systems based on a few crops, animals and related subsidiary professions. The integrated farming system envisages harnessing the complementarities and synergies among different agricultural sub- systems/enterprises and augmenting the total productivity, sustainability and gainful employment.

WHAT ARE THE GOALS OF AN INTEGRATED FARMING SYSTEM?

Integrated farming systems have the following four primary goals:

1. Maximization of the yield of all component enterprises of the integrated farming system to provide steady and stable income at higher levels.
2. Rejuvenation/amelioration of the system's productivity and achieving agroecological equilibrium.
3. Control the build-up of insect pests, diseases and weed population through crop rotation (diversification) and keep them at a low level of intensity.
4. Reducing the use of chemical fertilizers and other harmful agrochemicals and pesticides to provide pollution-free, healthy produce and environment to the society at large.

OBJECTIVES OF INTEGRATED FARMING SYSTEM

Following are the most important objectives of Integrated farming systems:

- ❖ To integrate different production systems like dairy, poultry, livestock, fishery, horticulture, sericulture, apiculture, etc. with crop production.
- ❖ To increase farm resource use efficiency to increase the farm income and gainful employment opportunities.

- ❖ To promote multi-cropping for crops of economic value to sustain land productivity.
- ❖ To maintain environmental quality and ecological stability.

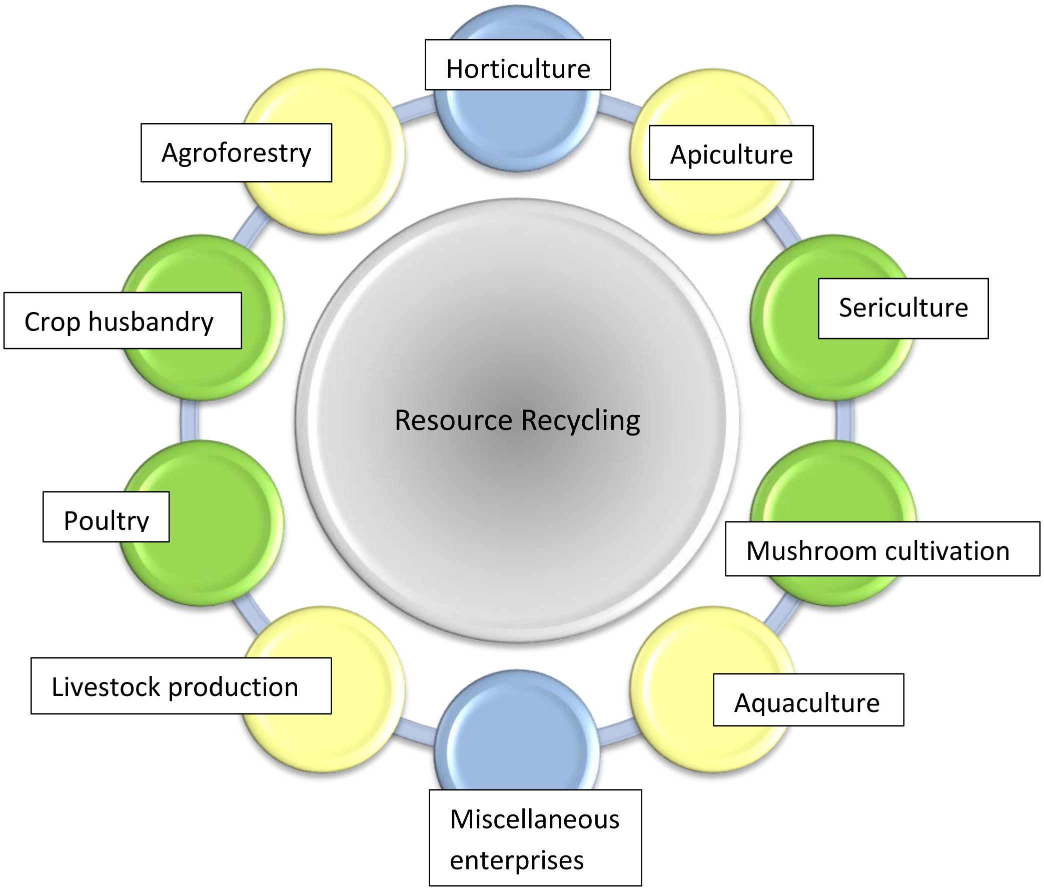

Figure 1 Different components of the Integrated Farming System

COMPONENTS OF INTEGRATED FARMING SYSTEM

Integrated farming systems may have various components as shown in figure 1. While selecting these components, local adaptation, socio-economic condition, geographical region, marketing facilities, transportation etc. need to be considered for an individual farmer, village and region. All the components in integrated farming systems must be interlinked to support each other and maximize the efficient utilization of each product or by-product.

ADVANTAGES OF INTEGRATED FARMING SYSTEM

- ❖ Helps to efficiently recycle and utilize the available resources
- ❖ Maximize the profit
- ❖ Increase employment opportunities
- ❖ Increases farm productivity
- ❖ Increase the environmental safety and sustainability

- Helps in providing balanced food for farm family
- Adoption of new technology
- It is an energy-saving approach
- Reduce the fodder crisis issues
- Reduce the fuel and timber availability issues

MAJOR CONSTRAINTS ADOPTION OF INTEGRATED FARMING SYSTEM

- The complexity of the integrated farming system due to multiple enterprises' adoption
- The development of an integrated farming system is time-consuming
- Lack of transport and marketing at the village level
- Non-availability of improved inputs
- Requirement of continuous supervision and monitoring
- Lack of financial support/heavy investment in the initial stage

CONCLUSION

Overall, it can be concluded that the adoption of an integrated farming system by selecting the appropriate combination of agricultural enterprises based on the specific needs and suitability to the specific agro-climatic conditions, and socio-economic situation of the farmer is essential for augmenting the income of a farm, increasing productivity, profitability, sustainability and family labour employment.

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POND-BASED INTEGRATED FARMING SYSTEM

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ABSTRACT

Farming is subjected to several biotic and abiotic factors. Ever increasing population and shrinking land holding is another issue of concern for food security in rural India. Adoption of the farming system based on location specificity may play a big role. Generally available farm ponds in rural areas act as a collection point of rainwater to recharge groundwater through infiltration and are also utilized for livestock and fisheries. An integrated agricultural system based on ponds may serve to boost job prospects, income, and crop yield. Consequently, integrated farming systems provide a solution to the issues of food and land crises and also help to enhance the farmers' quality of life.

INTRODUCTION

In India, the factor productivity is declining which is a serious concern resulting in a decline in per capita food availability in rural areas. This issue can be partially resolved by pond-based integrated farming. The management and conservation of soil and water resources, used for various farm needs are greatly aided by farm ponds. Farm ponds are water harvesting structures formed by the construction of a small embankment across a field waterway or by excavating a dugout. These are mainly used for farming, flood control, recreational purposes, drinking, fishing, watering livestock, fire control etc. Integrated Farming System (IFS) represents an appropriate mix of farm enterprises like horticulture, livestock, fishery, forestry, poultry *etc.* and the means available to the farmer to raise their profitability. It is a decision-making unit for a whole farm management system to deliver more sustainable agriculture to transform the land, capital and labour into useful products, which can be consumed or sold for surveillance. Integrated Farming involving aquaculture has been broadly defined as the concurrent or sequential linkage between two or more activities, of which at least one would be aquaculture. Here, the benefits of integration are synergistic rather than additive; and the fish, livestock, agriculture or other suitable components may benefit to varying degrees. In India, this kind of farming derives inputs chiefly from agriculture and animal husbandry which consists of the culture of fish combined with the husbandry of domesticated animals such as pigs, ducks, poultry, cattle, etc. as well as small horticulture on the dykes or over scaffolds around the ponds. In the face of the shrinking average size of landholdings, balanced growth in the state necessitates more equitable and efficient utilization of its land resources.

In terms of water storage, farm ponds are one of the best options for capturing extra runoff. They are mainly used for farming, drinking, fishing, fire control, cooking etc. By raising the water level in wells, these structures aid in groundwater conservation. Producing a variety of food crops through pond-based integrated farming helps to address the hunger issue. It also helps to improve the living standards of farmers by increasing crop production, job opportunities, high-income levels, etc. Farm ponds are considered life-saving irrigation of crops. It provides protective irrigation in times of delayed monsoons. Farm ponds have more effect on microclimate. These structures can be used in all watersheds with suitable modifications depending on soil types and slopes

SYSTEM APPROACH

A farming System is an approach to agricultural research and development that view the whole farm as a system and focus on 1) the interdependencies between the components under the control of members of the household and 2) how these components interact with each other in respect of physical, biological and socio-economic factors, not under the household's control (Shaner *et al*., 1982). Indian economy is predominantly rural and agriculture oriented where the marginal and small farmers constitute 76.2% of the farming community. Due to the failure of the monsoon, the farmers are forced to judicious mix up agricultural enterprises like dairy, poultry, pigeon, fishery, sericulture, apiculture etc., suited to their agro-climatic and socio-economic condition.

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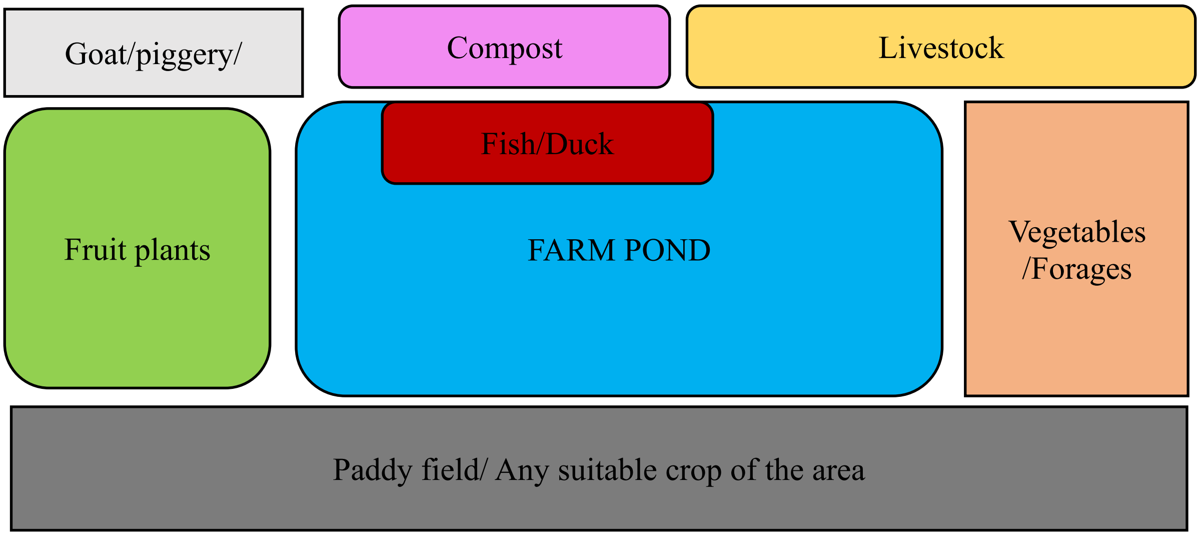
MODELS



BENEFITS

Pond-based integrated farming, in addition to increasing production and profit, also aided in the utilisation of family labour and decrease labour costs. The bonds between family members are also strengthened as a result men and women worked together to prepare trellises, clean ponds and their surroundings, harvest and sell fish and vegetables, and other tasks. It displays gender parity. Pond-based integrated farming management provides a way to address the growing food demand and the diversification of dietary preferences. Additionally, integrated farming contributes to the sustainability of poor farmers' livelihoods. Pond-based integrated farming was a great method for generating money for rural households with limited resources and ensuring sustainable output with no labour costs.

RESEARCH EVIDENCE

Farming in the eastern Himalayan region of India is a high-risk activity due to climatic uncertainty, lack of resources for small and marginal farmers and non-adoption of improved technologies. Pond-based integrated farming system (IFS) is a whole farm approach that aims to increase production, employment and income through the integration of various farming enterprises (rice, vegetables, fruits, fish, pigs, poultry, goat and others) as per climate, social acceptability and market demand. Eleven farm pond-based IFS models were evaluated in 150 farmers' fields covering a 22.5 ha area in the South Garo Hills district of Meghalaya, India during 2009–14 in a participatory approach. The individual farming system unit considered in the present study was 0.15 ha. The study revealed that the productivity and income of farmers under pond-based IFS improved substantially over farmers' practice. The Sustainable Value Index and System Economic Efficiency of IFS models 6 and 8 (6 (pond + rice + vegetables + pig integration, 4.04 Mg) followed by model 8 (pond + vegetable + pig + fruit integration, 4.02 Mg)) were much higher than other models. The overall results revealed that pond-based IFS has the potential to provide year-round food, nutrition, and employment opportunities and substantially increase the income of resource-poor rural households of the study region in Eastern Himalayas, India (Das *et al.*, 2021)

Pond-based farming is beneficial in increasing farm income, creating employment opportunities and improving soil health. The system is useful in minimizing risk, encouraging biodiversity, and improving the ecosystem as a whole. Farmers can get fresh, nutritious and balanced food for a healthy lifestyle. The promotion of a large number of such systems may act as a series of miniature water and nutrient harvesting structures for harvesting the costly plant nutrients, organic matter, soil and water, which would otherwise be dumped into the sea. With global warming and climate change, a more departure in frequency, intensity and amount of rainfall is expected and thus, the utility of these miniature structures may assume greater importance in future, especially in tropical climatic regions (Rautaray *et al*., 2012).

CONCLUSION

Farming is subjected to several biotic and abiotic factors. Ever increasing population and shrinking land holding is another issue of concern for food security in rural India. Adoption of the farming system based on location specificity may play a big role. Generally available farm ponds in rural areas act as a collection point of rainwater to recharge groundwater through infiltration and are also utilized for livestock and fisheries. An integrated agricultural system based on ponds may serve to boost job prospects, income, and crop yield. Consequently, integrated farming systems provide a solution to the issues of food and land crises and also help to enhance the farmers' quality of life.

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