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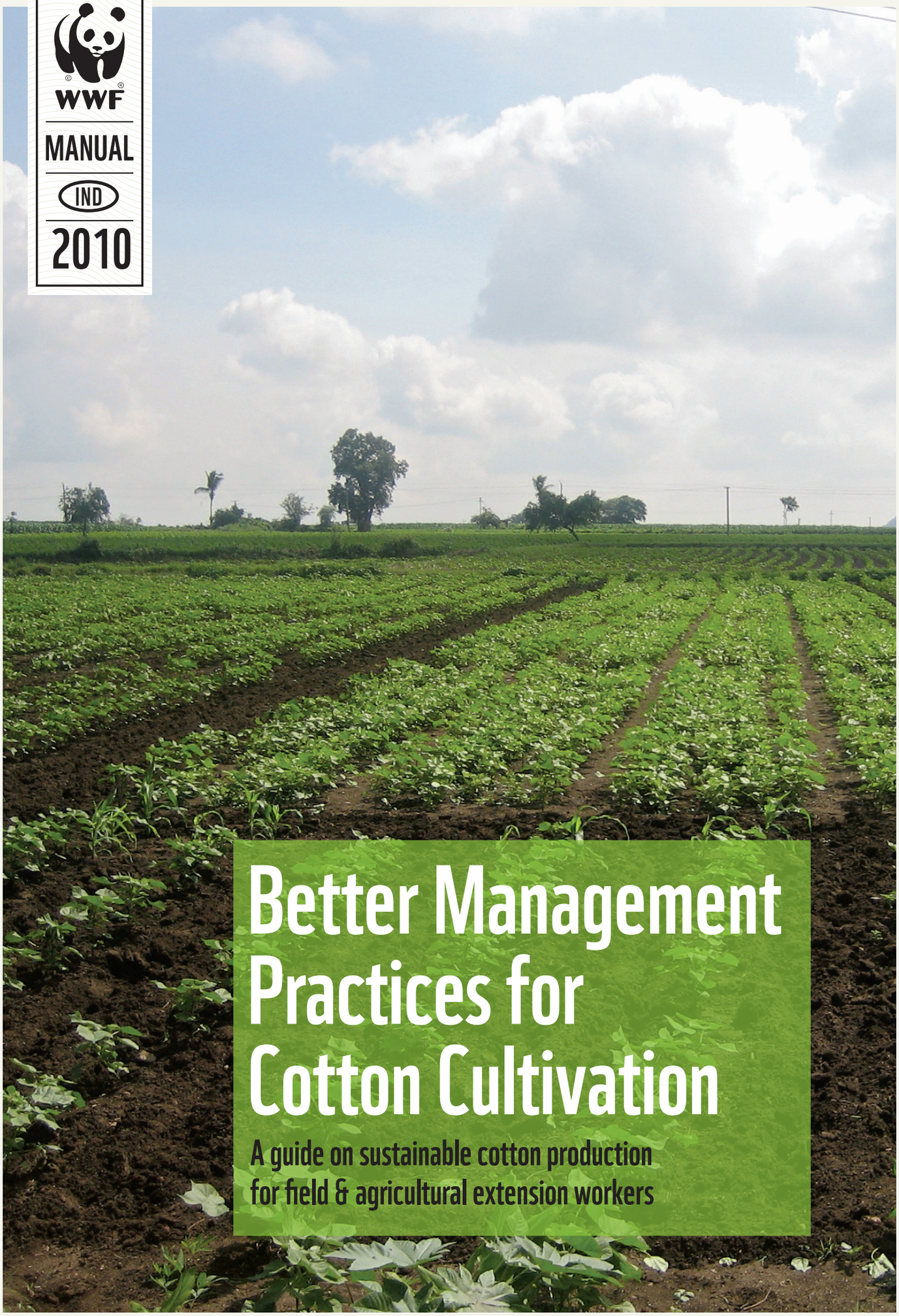

Better Management Practices for Cotton Cultivation

A guide on sustainable cotton production for field & agricultural extension workers

MANUAL ON BETTER MANAGEMENT PRACTICES FOR COTTON CULTIVATION

Conceived and contributed by:
Murli Dhar
P. Vamshi Krishna
Sumit Roy

Support from:
Dr. Y. G. Prasad, Central Research Institute for Dryland Agriculture (ICAR), Hyderabad
Dr. K. V. Rao, Central Research Institute for Dryland Agriculture (ICAR), Hyderabad
Modern Architects for Rural India, Warrangal, Andhra Pradesh
Krishi Vigyan Kendra, Jalna, Maharashtra

Edited by:
Bhavna Prasad
Malika Gupta
Shaila Sam

Designed by:
Mallika Das

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The manual is a part of the project 'Cotton in India - Challenges and Opportunities to Implement Better Cotton' supported by WWF-Sweden. Through this initiative WWF-India has attempted to guide the field worker and agricultural extension staff to execute Better Management Practices in cotton at field level.

Manual on better management practices for cotton cultivation

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1.0 INTRODUCTION

Cotton is one of the most important fiber's and cash crop's of India and plays a dominant role in the industrial and agricultural economy of the country.

India has emerged as the second largest producer of cotton in the world and occupies the first position in terms of total area under crop production at over 9.44 million hectares. However, the productivity level is still below the world average. Efforts are in place to increase the current productivity to bring it closer to the world average. In addition to meeting the cotton consumption demands by domestic textile industry, India has surplus cotton available for exports. The productivity level of cotton in India varies from zone to zone (Fig. 1).

NEARLY 65 PER CENT OF THE COTTON CROP IS CULTIVATED UNDER RAINFED CONDITIONS IN THE COUNTRY

In India, there are nine major cotton growing states which fall under three zones viz. the North Zone (Punjab, Haryana and Rajasthan), the Central Zone (Maharashtra, Madhya Pradesh and Gujarat), and the Southern Zone (Andhra Pradesh, Karnataka and Tamil Nadu). Nearly 65 per cent of the cotton crop is cultivated under rain fed conditions in the country.

The crop is generally grown in medium to deep black clayey soil, but is also grown in sandy and sandy loam soil through supplemental irrigation by farmers. Cotton is best grown in soils with an excellent water holding capacity. Aeration and good drainage are equally important as the crop cannot withstand excessive moisture and water logging. The major soil types suitable for cotton cultivation are alluvial, clayey and red sandy loam. Cotton is grown both under irrigated and rain fed conditions.

Being a cash crop, cotton is known for its intensive cultivation. Some production practices like wide plant to plant and row to row spacing and crop traits such as indeterminate growth habit, long duration, render the crop susceptible to a multitude of pests and diseases at all stages of growth. These factors are also responsible for high input use in terms of nutrients and crop protection chemicals. Aggressive production practices by farmers often lead to a very high input use, with little regard to matching returns. The excessive use of inputs, not only escalates the cost of cultivation but also decreases the profitability. It also results in pest resurgence, health and environmental hazards. Needless to say, excessive use of inputs is laying enormous pressure on land and water. In order to address these issues, WWF-India has developed the concept of operationalizing Better Management Practices (BMPs) for cotton cultivation. BMPs help balance inputs with increased farm yields. This manual has been developed in order to guide the extension worker at the field level to execute Better Management Practices in cotton growing areas. The manual has emerged from the field experiences and results obtained by WWF-India, Thirsty Crop team. The manual outlines the importance of environmentally sustainable cotton production systems and provides information on the methodology and technology pertaining to cleaner and more profitable cotton cultivation.

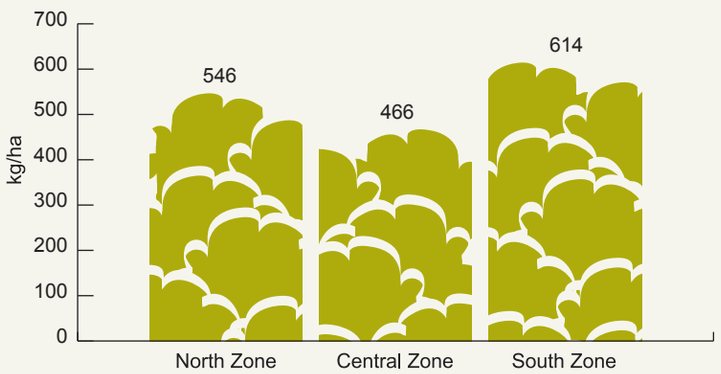

Figure 1
Varied productivity level of cotton in India (zone to zone)

2.0 DEFINING BETTER MANAGEMENT PRACTICES

Better Management Practices (BMPs) are agricultural practices which optimize the three pillars of sustainability: social responsibility, environmental integrity and economic viability by binding together, the financial requirements for agriculture, such as high yield with environmental and social concerns, such as water and pesticide use.

These practices allow diverse actors such as farmers, companies, government agencies, NGOs to optimize resource use efficiency, create marketable products, reduce waste, assure market access and reduce the risk of adverse relations with local stakeholders.

Better Management Practices, technically speaking, are more environment friendly, and promote the use of local resources, and improve the input use efficiency. The practices, apart from improved agronomic practices, can be broadly categorized into five broad areas, namely:

- Soil Fertility Management
- Water Management
- Pest and Disease Management
- Proper Harvesting and Storage
- Crop Residue Management

3.0 SOIL MANAGEMENT

3.1 Soil Nutrition

Most of the cotton growing tracts in the country are characterized by low to medium levels of available Nitrogen (N) and Phosphorous (P) and medium to high levels of available Potassium (K). Organic matter content varies between 0.3 – 0.56%. Needless to say, the fertility index of cotton growing soils is not very encouraging. Furthermore, the extraction of nutrients is enormous as cotton is a deep rooted crop. Again the nutrient uptake varies with the soil type. Cotton is generally grown in vertisols of varying depth (shallow, medium deep and deep soil) in the rainfed regions of the central zone. More than 67% of the cotton growing areas fall under shallow and medium deep soil. The nutrient uptake of cotton in different soil types is given below:

Soil Type	N uptake (kg/ha)	P uptake (kg/ha)	K uptake (kg/ha)
Deep	55	20	57
Medium deep	44	13	43
Shallow	44	12	45

(Source: Pundarikakshudu et al 1992)

It is therefore important to replenish the soil nutrients through balanced fertilization for long term sustainability. In order to enhance the nutrient use efficiency it is important that the nutrients are applied at the right times, in right quantities and using appropriate methods.

Nutrient	Method of application
Nitrogen	The recommended dose of N fertilizer as split into three applications:1/3rd quantity each at 30, 60 and 90-days after sowing
P & K	Entire recommended dose of P fertilizer to be applied as a basal application at the time of last plough. Recommended dose of K split into three applications: 1/3rd quantity each at 30, 60 and 90 days after sowing

(Source: CICR & KVK, Jalna)

The recommended doses for a given area and under different farming systems have to be ascertained from the local agricultural research stations.

3.2 Soil Characteristics

Apart from the nutritional capacity of the soil, there are other aspects which need serious attention:

Soil Respiration: For the soil to be healthy, air is necessary. Soil should be loose and friable for adequate air circulation. Earthworms, insects, microorganisms and plant roots help in loosening the soil and facilitate good aeration.

Soil Moisture: For the soil to be healthy, it should have good water holding capacity. For the rainwater to percolate into the soil without wastage through run off, the soil should be loose and friable. In addition to the soil microbial organisms, organic matter content helps in holding water.

Soil Resilience: The ability of the soil to withstand various natural processes and management interventions and still be amenable for sustainable crop production is known as its resilience. Soil needs to be protected from wind and water erosion. Management

practices that help build up the soil organic matter and microbial activity are important to safe guard the productivity of soils. Ensuring proper land use and land cover through appropriate measures such as mulching, cover cropping and crop residue recycling improve its regenerative capacity.

3.3 Identification of plant nutrient deficiency symptoms

All nutrients play an important role in the metabolic activities of a plant. A nutrient higher in quantities cannot replace the role of another deficient nutrient. Plants express deficiency of a nutrient through symptoms on their leaves, stems and in their growth.

Some nutrients are highly mobile, some less mobile while some immobile in the plant system after uptake by the plant through its roots from the soil.

Highly mobile nutrients include Nitrogen, Phosphorous, Potassium, Magnesium and Chloride. When the soil becomes deficient of these nutrients, the deficiency symptoms first appear on the lower / older leaves of the plant as these nutrients get translocated to the younger leaves / apical growth because of their mobility in the plant system.

Immobile nutrients are Iron, Boron, Copper and Calcium. When the soil is deficient in these nutrients, they cannot move towards apical parts of the plants as they are immobile, the deficiency symptoms appear first on the apical parts of the plant (upper /younger leaves).

Nutrients with limited mobility include: Zinc, Sulphur, Manganese and Molybdenum

N Deficiency: Early season deficiency results in the plant with pale green yellowish leaves and stunted growth and late season deficiency leads to reduced boll retention.

P Deficiency: Reflected in the lower leaves, plants are stunted and have dark green leaves, sometimes impart a *purplish yellow color to the leaf*.

K Deficiency: Reflected in the lower leaves, *occurs* as interveinal chlorosis, *dry* leaves and *premature shedding*.

S Deficiency: Seen on upper young leaves, first turn to light green, *then* to light yellow followed by a pronounced yellowing.

Ca Deficiency: Manifests as deformed and chlorotic leaves at the growing tip and stunted growth.

3.4 Soil test based nutrient application

COTTON IS GENERALLY PRONE TO SECONDARY NUTRIENT DEFICIENCY PARTICULARLY MG.

Soil should be tested for its chemical properties by using the portable soil analysis kit. The analysis report can be used to plan the fertilizer application. Micro nutrients deficiency is made up with proper application of compost / manure along with the main fertilizer.. Cotton is generally prone to secondary nutrient deficiency particularly Mg. In case of visible deficiency symptoms, Mg and other micro nutrients are applied as foliar sprays at appropriate growth stages.

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Soil testing kit being used for field soil testing

3.5 Organic Practices

Better Management Practices have been developed in such a way that they require the use of organic input practices in conjunction with inorganic fertilizers.

Different practices are mentioned *below* so that farmers can use these simple techniques and enhance the soil organic matter.

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Tank Silt Application

Tank Silt Application: Tanks are the naturally formed depressions (small lakes) with a strengthened bund. Tanks are the unique irrigation structures in the Warangal district of Andhra Pradesh. They normally have catchments that are rich in nutrients. Soil loss in the catchments along with run off results in sedimentation of fertile top soil in the tank bed. The silt, which is finer fraction of the soil deposited in the tanks, is excavated and applied as an external amendment in cotton fields to improve water retention capacity and fertility. Tank silt application has to be taken up as a group activity, which is encouraged in this project.

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Preparation of vermicompost

Vermicompost: Non-burrowing earthworms can convert organic crop and animal residues into compost which is rich in both major and minor nutrients and other plant growth promoting substances. Farmers are aware on the use of vermicompost. The project supports the farmers to produce vermicompost by constructing simple, low cost vermicompost beds. Cement rings (3-4 feet diameter) are prepared at the village level as a group activity, which reduces the cost of construction. These cement rings are then used in constructing the compost beds. Farmers are encouraged to use 2-3 quintals of vermicompost per acre, as per the availability.

Cattle penning

Farm Yard Manure Application

Application of Amurtha Jalam

Sheep penning, cattle penning and poultry manure: Farmers are encouraged to use sheep penning and poultry manure. Sheep penning and poultry manure are used in the cotton fields, where tank silt can not be applied. This is suggested to reduce the cost of cultivation and to use resources efficiently.

FYM Application: Farm Yard Manure (FYM) is generally applied in cotton fields. Farmers understand the importance of FYM application and feel the need for it; therefore additional efforts are not required to motivate them. However, there is a greater need to motivate the farmers to change the technique of FYM preparation, as the process is prone to nutrient loss in conventional methods. FYM should not be opened to the sun and should be protected from rain, if possible. Occasional stirring or agitation can provide good aeration during decomposition.

Amrutha Jalam: "Amrutham" literally means elixir. Amrutha Jalam works as an elixir to the soil, improving *its* productivity. Amrutha Jalam is prepared with cow dung (approx 5 kg.), cow urine (approx. 15 l), ghee (250 g), jaggery (2 kg), which is diluted in 200 l of water. This mixture is allowed to putrefy for 7 days in a drum or a cement tank. This solution can *then* be applied to one acre land as a top dressing to the soil at the base of the plant either manually or with the help of a spray tank after removing the nozzle or along with irrigation water. This practice helps in building up of favourable microbial activity and other soil organisms, apart from providing some amount of moisture and nutrients during dry spells.

4.0 WATER MANAGEMENT

BMPs on water management are developed to improve the water use efficiency in irrigated cotton.

The water related BMPs include adoption of water conservation techniques like drip irrigation and innovative techniques like paired row planting of cotton (60 cm apart as against 90-120 cm apart) coupled with 120 cm inter spaces between 2 paired rows. Other methods include skip row irrigation and furrow application technique by farmers who otherwise adopt flood irrigation irrespective of row length.

4.1 Critical stages of moisture requirement for cotton

There are many stages during crop cultivation, when moisture is important for its growth. Moisture is critical at the entry level of each stage. If the plant undergoes water stress during these stages, yields are significantly reduced. Following are some points that the extension worker should keep in mind with respect to irrigation.

- If water is available for one irrigation, it should be provided at the flowering stage
- If water is available for two irrigations, it should be provided at the flowering and boll formation stages
- If water is available for three irrigations, it should be provided at the seedling, flowering and boll formation stages
- If water is not limited, irrigation should be provided every 15 days and water stagnation should be avoided.

4.2 Water Management practices in cotton cultivation

Straight Furrow: This is a surface irrigation method provided in between two furrows. Furrows are developed between cotton crop rows during planting and interculture. Water is applied by running small streams in furrows between crop rows. Water infiltrates into the soil and spreads laterally to irrigate the area between the furrows.

Alternate Irrigation: Under this method, the area in between the rows is irrigated using a combination of flood and furrow irrigation. In case of cotton, irrigation can be provided to alternate rows, by skipping a row to save water usage. This has the potential to save around 35% of irrigation water in comparison to the conventional furrow method in sandy loam soil.

Paired Row Technique: Paired row technique is an extension of alternate irrigation. It is a method in which additional crop rows are added on both sides of the furrow, besides increasing the ridge spacing, thereby allowing one furrow to irrigate two paired rows. The paired row system of planting cotton crop can save around 30 % of irrigation water with no reduction in the yield as compared to the conventional furrow system.

Drip Irrigation

Drip Irrigation Method: Application of drip or micro irrigation results in saving water and enhances the water use efficiency of cotton to a great extent. Regulated and slow application of irrigation water through emitters/orifices enables the water to reach the root zone of plants at frequent intervals. Drip irrigation has been found to enhance the yield of cotton by 27% (INCID 1994).

5.0 PEST AND DISEASE MANAGEMENT

During 1920's, 34 types of insects were identified in cotton, among which, nine pests could cause severe losses. Now the insects damaging cotton number around 100, out of which 15 insects can cause severe losses.

Reasons for more pest attacks in cotton:

- Use of monocropping, or use of sole crops without in field diversity.
- Higher number of irrigations and use of chemical fertilizers, applied for higher yields increase's susceptibility.
- Indiscriminate spray of chemical insecticides even under low infestations kills the beneficial insects and upsets the ecological balance. This is also responsible for development of insecticide resistance.

Capacity building of farmers is essential for a sound pest management plan. Knowledge and the ability to distinguish pests and beneficial insects helps in appreciating the ecological services of parasitoids and predators. The practice of regular pest and disease monitoring (weekly) enables estimation of pest attack and consideration of appropriate management options. When the pest population numbers exceed the number of beneficial insects, the farmer should adopt suitable interventions, thus giving due consideration to natural pest regulation. On-farm natural resources should be preferred for plant protection to reduce the external input costs.

Bio-intensive Integrated Pest Management practices should receive priority over chemical pesticide applications.

Ploughing practices: Boll worms during pupal stage hide in debris, stubbles and upper layers of the soil. Summer deep ploughing practices are adopted to expose them to sun light. It helps to expose the pupae of bollworms, which are exposed to sunlight and predation by birds.

Enrichment of compost to fight soil borne plant diseases: When compost is enriched by mixing and growing natural antagonistic fungi (*Triochoderma*) and applied as a top dressing at the base of the plants, the practice helps in effective deployment of biocontrol fungus to control wilts and other soil borne diseases, apart from promoting plant growth.

Trap, border and inter crops: Trap and border crops like marigold, castor, maize, sorghum and pigeon pea are grown in cotton fields to serve as trap crops for insects (mostly bollworms) and to increase the in-field and border diversity to serve as barrier or guard crop for reducing pest dispersal and in some cases to serve as food resources for enhanced multiplication of beneficial insects. Green gram, as an intercrop, not only brings in additional income, but also helps in in-situ conservation of soil moisture and promotes the development of natural enemies of pests thereby reducing the pest incidence on cotton.

Intercropping

Pest	Recommended trap crop (100 plants/acre)
Bollworm, *Helicoverpa armigera*	Marigold, sunflower, sorghum, pigeonpea
Bollworm & tobacco caterpillar, *Spodoptera litura*	Castor
Spotted bollworm & Pink bollworm	Okra

Helicoverpa infestation in cotton leaves

Marigold on field bunds can attract *Helicoverpa* bollworm and castor can attract tobacco caterpillar.

Pest monitoring at weekly intervals can help the farmers identify eggs layed by these insects that are collected and destroyed. Tobacco caterpillar is generally found in groups during the first 5 days after hatching, under infested leaf surfaces, which then show up as papery-white patches due to larval scrapping of leaves and these can be spotted from a distance, manually picked and destroyed. Marigold, castor, bhindi, sunflower should be sown as trap crops and monitored for pest incidence.

Pheromone traps: Female insects release a kind of scent to attract male insects for mating. Male insects get attracted to this smell and wander to the source of the smell. This chemical attraction is species specific. Synthetic insect specific pheromones are available as lures for deployment in suitable dispensers housed in traps designed for maximum catching efficiency of attracted adult males (moths). The whole apparatus is deployed in the field tied to a wooden stake one foot above the crop canopy. The pheromone trap serves the purpose of tracking the onset of pest activity in the field. Trapped insects during the night are counted the next day and removed after enumeration. Based on the intensity of pest infestation, control measures are adopted. Separate pheromone traps are available for *Helicoverpa*, tobacco caterpillar and pink bollworm. The farmer, based on his experiences of pest infestation, can opt for specific pheromone traps for estimating the intensity of the pest attack.

Yellow color trap

Color traps: Some sucking insect pests get attracted to specific colours. Colored boards/sheets/round tins should be arranged one foot above the crop by applying castor oil on each surface and tied to a stake. Yellow colour bait trap works for trapping whiteflies while white colour boards works for jassids. The insects attracted to the colour boards get stuck to the sticky traps and can be checked for the

intensity of the infestation in the field. Periodically the surfaces need to be cleaned and castor oil needs to be applied again. In one acre, 2-3 yellow sticky traps could serve the purpose of monitoring.

Light Trap

Light Traps: Many insects get attracted to light. Moths, butterflies, adult sucking pests get attracted to light or flame. The light trap idea is based on this behavior. An electric bulb of 100-150 watts along with a water trough below that at one feet distance should be arranged near the electricity source. Insects that get attracted to the light operated during night time fall in the water and get killed when few drops of kerosene/soap powder is added to water. Pests are observed flying in the field in the evening hours between 7-9 pm. Switching off the light beyond this time will not affect beneficial insects.

Bird Perches: In nature, many birds feed on insect larvae. Erecting T-shaped wooden poles in the field (10/acre) can serve as a perch for birds. These bird landings in the field promote natural pest control. Results are also observed by pouring water in broken mud pots. Some farmers spread rice mixed with turmeric in the field to attract birds. Shrikes, mynas and baya weaver birds land on bird perches. *Ideally*, four to five bird perches should be arranged one ft above the crop.

Neem seed oil extraction

Botanical extractions like neem seed kernel extract, vitex decoction, tobacco decoction and neem oil are used for pest control. Through weekly monitoring, the diversity and intensity of the insects can be understood. At times, when there are no beneficial insects in the field and when the conditions are not favourable for them, the pest intensity will be higher.

Under favourable conditions sucking pests spread across the entire field in a short time. When the farmer feels the pest situation is out of control, he should prepare the extracts from the available trees in the village.

When adult pests are attracted to light or trapped in pheromone traps, neem sprays and concoctions prepared from five leaves should be sprayed to avoid egg laying by bollworms. These sprays are intended to bring back the natural balance of pests and beneficial insects, but not as an alternative to chemical sprays. Based on the diversity and intensity of pests, extracts should be sprayed to bring back the natural balance.

Bio pesticides are also recommended for controlling bollworms.

6.0 HARVEST AND STORAGE

Better Management Practices also emphasize safe and clean picking and storage practices to promote clean cotton for better prices and markets.

6.1 Picking of cotton

The time of picking is an important aspect for maintaining seed quality. Picking should only commence when the cotton is fully mature, i.e., when the bolls begin to open. Several pickings may be necessary since bolls ripen every two to three months. Early cotton picking gives slightly better seeds for germination. In addition, the planting seed is best gathered at the peak of the harvest. The cotton picked from late-formed bolls (last pickings) should not be kept for seeds.

6.1.1 Precautions to be taken in picking:

1. Picking should be started when bolls are fully mature.
2. Picking should not be done while the bolls are wet from dew or rain.
3. Bolls spoiled by rains, or damaged by insects, or otherwise damaged, should be picked separately and discarded. Such bolls can be picked 10 to 15 days ahead of the first picking. The damaged bolls should not be picked during normal pickings for seed purposes.
4. Cotton should be clean, with a minimum amount of material such as leaves and plant parts. This reduces the possibility of mechanical damage from excessive machining of the fibre during ginning.
5. Moist cotton should not be picked or stored in any way. At a moisture content of twelve per cent, or more, heating may occur and damage the seed and fibre. Further, damp cotton requires more processing in the gin.
6. The picked cotton, when it is completely dry, should be stored in a dry place and should be covered if not ginned immediately.

6.1.2: Using of cotton picking aprons:

WWF-India along with its implementing partner Krishi Vigyan Kendra (KVK) is introducing cotton picking aprons for women pickers. The apron has got the following characteristics:

Cotton picking apron

- It is made up of cotton cloth with a polyester sac at the back with a storage capacity of 7-9 kgs and with foam belts on the shoulders.
- It is easy for any ordinary woman with minimum knowledge of sewing to tailor the sack and therefore has a higher chance of uptake.
- The sack with half inch foam belts, resting on two shoulders, reduces the stress of carrying the weight of picked cotton, making it easier for women to pick cotton.

7.0 CROP RESIDUE MANAGEMENT

The cotton stalks after harvest are largely wasted (either burnt) or inefficiently used (as firewood). The stalk can either be used as briquette (densified and energized) or as organic manure after composting.

Cotton stubbles contain more than 1.11% of Nitrogen, 0.1% of Phosphorous, and 3.98% Potash. *This* means that the grown crop can supplement 1.5 tons of Carbon, 20-25 Kgs of Nitrogen, 72 Kgs of Potash from the cotton stubbles collected from one hectare of cotton cultivated area. The stubbles can be chopped through a chipper to chips or powder. The chips can be used as a feeding material for composting process, or in vermicompost preparation and other compost pits. Commercial microbial cultures can be used on the chips/ powder of stubbles to hasten the decomposition process.

Otherwise, with the help of a rotavator, a tractor driven machine, the stubbles/stalk can be chopped in the field and residues can be incorporated into the soil, as it can till the soil up to 6 inches. This operation should be taken up well before the rainy season so as to permit *faster* decomposition of the chopped stubbles. This operation improves the soil porosity and productivity. It also helps in leveling of the soil, and retains the moisture.

There is another way of utilizing the cotton stubbles by forming briquettes. Cotton stubbles inherently have substantial energy content. The energy content varies from 17 MJ/kg to 18 MJ/kg. The stubbles can be chopped and then processed mechanically in a briquetter to form briquettes. These briquettes can be used as a renewable source of energy in substitution to fossil fuel.

8.0 ECONOMICS AND PROFITABILITY

It has been found that undertaking these Better Management Practices results in financial benefits for the farmers, in addition to maintaining soil sustainability.

The advantage that BMP cotton cultivation has over conventional cotton cultivation is the significant reduction in input costs. A typical cost benefit analysis of BMP is given below:

Sl. No	Description	BMP farmers (all)	Conventional farmers
1.	Mean Seed cotton yield (ton/acre)	0.9	0.9
2.	Mean price (Rs/quintal)	2300	2300
3.	Returns (Rs/acre)	21298	21712
4.	Mean Manure cost (Rs/acre)	821	656
5.	Mean fertilizer cost (Rs/acre)	767	995
6.	Mean pesticide cost (Rs/acre)	244	823
7.	Mean seed cost (Rs/acre)	750	750
8.	Mean labour cost (Rs/acre)	3541	3815
9.	Harrowing cost (Rs/acre)	1073	1047
10.	Land preparation cost (Rs/acre)	415	291
11.	Summer ploughing cost (Rs/acre)	671	778
12.	Total variable cost (Rs/acre)	8282	9155
13.	Gross margin (Rs/acre)	13016	12557
14.	Benefit cost ratio (Rs/Rs)	1.57	1.37

(Source: WWF India & CRIDA)

9.0 MONITORING METHODOLOGY FOR ASSESSING THE BMP PERFORMANCE

The performance of Better Management Practices developed by WWF-India should be monitored by keeping a record of the activities implemented in the field. Monitoring the performance of BMPs allows the farmer to assess the right level of application of inputs, thereby reducing fertilizer application. It also helps in pest identification, reducing use of chemical pesticides and water consumption, increasing productive use of water and increase in cotton yield and profitability.

Farmers should be encouraged to maintain a farmer's diary for keeping a record of all the activities performed. This will help the farmers understand the benefits derived from adoption of Better Management Practices in terms of reduction of inputs, increase in the yield and improved profitability. The present section describes the monitoring parameters and methodology to be adopted for gathering information at the field level.

9.1 Crop sowing

Sl. No.	Details	Values	Methodology
1.	Area sown under BMP cotton (ha)		Measuring the dimension of the field allotted to BMP cotton
2.	Seed Rate (kg/ha)		Weight of seed applied and represented in kg/ha
3.	Seed Cost (Rs/ha)		Cost of the seed and represented in Rs./ha
4.	Man days involvement in seed application		No. of labours x No. of days
5.	Cost of sowing (Rs/ha)		Labour cost + Cost of seed and represented in Rs./ha
6.	Seeds Spacing (m)		Distance between two planted seeds
7.	Intercropping		Details of the intercrop
8.	Details of seed treatment		Amount of chemical/bioagent used

9.2 Land preparation

Sl. No.	Details	Values	Methodology
1.	No. of operations		Recording total no. of operation in a single season
2.	Types of operation		Tractor driven/Bullock Cart driven
3.	Machineries used		Tractor/Bullock Cart
4.	Cost towards machinery used (Rs/ha)		Rent of tractor/diesel cost, etc.
5.	Man days involvement		No. of labours x No. of days
6.	Cost of land preparation (Rs/ha)		Labour cost + Cost towards machineries used and represented in Rs/ha

9.3 Fertilizer/Manure application

Sl. No.	Details	Values	Methodology
1.	Types of fertilizers used		Recording the brand name and composition of the types of fertilizer used
2.	No. of times a fertilizer is applied, for each type of fertilizer		In a cropping season
3.	Amount of fertilizer used for each type (kg/ha)		Weight of fertilizers used
4.	(N+P+K) applied in kg/ha		Recording the nutrient content from the brand of fertilizer used
5.	Cost of fertilizer (Rs/ha)		Total cost incurred in purchasing the fertilizer + transportation cost and represented in Rs./ha
6.	Man days involved in fertilizer application		No. of labors x No. of days
7.	Amount of organic manure/biofertilizer/ organic fertilizer used (kg/ ha)		Tractor load/Cart load/head load/bags to be represented in weight (kg) and projected in kg/ha
8.	Cost of organic manure/ biofertilizer/organic fertilizer (Rs/ha)		Total cost incurred in purchasing organic manure + transportation cost and represented in Rs./ha
9.	Man days involved in manure application		No. of labors x No. of days
10.	Total Cost in fertilizer & manure application (Rs/ha)		Cost of fertilizer + Cost of manure + total labour cost in applying fertilizer & manure and represented in Rs./ha

9.4 Water application

Sl. No.	Details	Values	Methodology
1.	Types of irrigation		Flood/Furrow/Drip/Canal
2.	Volumes of water applied (M3/hr/ha)		Pump discharge[1] (in litre/sec converted to M3/hr) x total hrs of pump running for entire crop cycle and represented in ha
3.	Electricity consumption for running pumps in Kw – hr		Capacity of the pump (HP converted to Kilo Watt) x hrs of running of pump
4.	Electricity cost (Rs/ha)		Cost per unit of electricity x total Kw - hr
5.	Other associated cost (Rs/ ha)		Cost of diesel required
6.	Total cost (Rs/ha)		Electricity cost + labor cost

[1]Pump discharge to be calculated for each and every individual by recording the time required to fill known volume of water

9.5 Pesticide application

Sl. No.	Details	Values	Methodology
1.	Types of pesticides used		Recording the brand name and composition of the types of pesticide used
2.	Main pest targeted		Identification of the pest
3.	No. of times of each type of pesticide applied		In a cropping season
4.	Amount of pesticide used for each type (g or ml/ha)		Weight/volume of pesticides used represented in g or ml/ha
5.	(Active ingredients) applied in g or litre/ha		Calculating the active ingredient from the composition of pesticide used
6.	Cost of pesticide (Rs/ha)		Total cost incurred in purchasing pesticides+ transportation cost
7.	Man days involved in pesticide application		No. of labors x No. of days
8.	Total cost in pesticide application (Rs/ha)		Cost of purchasing pesticides + total labor cost

9.6 Integrated Pest Management Practices

Sl. No.	Details	Values	Methodology
1.	Types of bio pesticides used		Recording the nature of the bio agents used
2.	Main pest targeted		Identification of the pest
3.	No. of times of bio pesticide application		In a cropping season
4.	Amount of bio pesticide used for each type (kg or litres/ha)		Weight/volume of bio pesticides used represented in kg or litres/ha
5.	Pest monitoring & management activities		Sampling/counting pest and beneficial; Using Pheromone traps, sticky traps, bird perches, trap crops
6.	Cost of bio pesticide (Rs/ha)		Total cost incurred in purchasing bio pesticides or production of bio pesticides at household level for a ha of land
7.	Cost towards pest monitoring & management activities (Rs/ha)		Cost of purchasing pheromone traps, sticky traps, etc.
8.	Man days involvement		No. of labors x No. of days
9.	Total Cost (Rs/ha)		Cost of bio pesticide + Cost towards pest monitoring & management activities + Labor Cost

9.7 Other intercultural operations

Sl. No.	Details	Values	Methodology
1.	No. of operations		In a cropping season
2.	Types of operation		
3.	Man days involvement		No. of labours x No. of days
4.	Cost of intercultural operations (Rs/ha)		Labor cost + If other cost is associated

9.8 Harvest records

Sl. No.	Details	Values	Methodology
1.	No. of pickings		From date of picking
2.	Seed cotton yield (kg/ha)		Weight of the harvest and represented in kg/ha
3.	Man days involvement for cotton picking		No. of labors x No. of days
4.	Cost involved in cotton harvest (Rs/ha)		Labor Cost + other cost like transport to gins, local market, cost of apron, etc
5.	Price received by selling seed cotton (Rs/kg)		Actual price received at the time of selling in Rs/kg

ABBREVIATIONS

BMP	Better Management Practice
CICR	Central Institute for Cotton Research
FYM	Farm Yard Manure
Gms	Grams
ha	Hectare
HP	Horse Power
K	Potassium
kg	Kilogram
KVK	Krishi Vigyan Kendra
KW	Killo Watt
ml	Mililitre
N	Nitrogen
NGO	Non Government Organization
P	Phosphorous
WWF	World Wide Fund for Nature

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+90

WWF- India, Thirsty Crop, Better Management Practices are being implemented in over 90 villages

2

Better Management Practices have been introduced in two states, Andhra Pradesh and Maharashtra

+15000

Better Management Practices in cotton is spread over an area of 15000 ha

+9000

Covers 9000 farmers

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WWF-India,172-B, Lodi Estate, New Delhi 110003