STEPS TO SUCCESSFUL COTTON PRODUCTION IN THE PHILIPPINES

General Requirements

Area Selection

Cotton grows best in areas with deep surface soil, high water holding capacity, good internal drainage and pH ranging from 5.5 to 7.0.

Planting Requirements

Planting Schedule. Planting dates vary from one area to another depending on rainfall and cropping systems.

Time of planting is important especially in rainfed areas to optimize available soil moisture. Early planting is encouraged to save on irrigation costs. It also allows the crop to enjoy a longer vegetative period, thereby, increasing its yield potential. On the other hand, late planting is done only in areas with adequate water source and adequate irrigation facilities. Planting dates suggested for the various cotton growing provinces (Table 1a & Table 1b) are based on rainfall data, cropping patterns, and results of field trials.

Cluster Planting. For more efficient and effective farm supervision, plant in production clusters. A production cluster consists of at least 15 hectares within one-kilometer radius.

Synchronized Planting. Planting in a cluster must be done within a 30-day period to prevent insect pest build up especially for late-planted cotton.

Resources and Facilities

For irrigated cotton, irrigation resources and facilities must be adequately and economically available.

Varieties

The recommended varieties for commercial planting are UPL-C2, CRDI-1 and CRDI-2. Three newly developed cotton varieties under seedproduction are PSB-Ct8, PSB-Ct9, PSB-Ct10 and NSIC-Ct11. UPL-C2 is high yielding with a close fruiting period, which is a built-in advantage for insect pest control and crop management. It is less preferred by leafhoppers, slightly tolerant to thrips and resistant to bacterial blight disease. Moreover, it has high lint recovery and average strength and medium fiber.

CRDI-1 is recommended for Mindanao. CRDI-2 is for Luzon and Visayas. It yields 10% higher than UPL-C2, highly resistant to leafhoppers and moderately resistant to damping off. Its lint recovery is comparable to UPL-
C2 and has lint qualities acceptable to textile mills. It is also high yielding, good for intercropping with garlic and legumes, and possesses good fiber qualities.

**Step 1. Land Preparation**

The field can be prepared using either the conventional or the minimum tillage method.

**Conventional Tillage**

For typical upland field, plow at least 15 cm deep (6 inches) then harrow two or three times for good soil tilth, good weed control, uniform seed germination and good plant stand. Then make furrows by passing an animal-drawn plow at recommended distance.

**Minimum Tillage**

In lowland field, cut stubble close to the ground immediately after rice harvest so as not to interfere with cotton seedlings. Clean the field by handweeding or by applying an appropriate herbicide (Table 2).

In saline areas, make furrow slices with one passing of an animal drawn plow at recommended row distances to remove the highly saline soil surface that adversely affects the germinating seedlings.

**Step 2. Basal Fertilization**

For the hill-drop planting method, apply basal fertilizer along the furrows before planting, then cover thinly with soil. For dibble planting, dibble the fertilizer 5-8 cm away from the seeds just after planting or within one week after emergence. Make sure the fertilizer does not come in contact directly with the seeds. Consult Appendix Table 1 on the recommended rate of fertilizer.

To maintain soil organic matter, liberally apply and incorporate with the soil plant residues and animal manure or any low cost organic fertilizer available in the farm.

**Step 3. Planting and Initial Irrigation**

**Certified Seeds.** Only certified seeds should be planted to ensure high seed germination, vigor, varietal purity and uniform field stand. These guarantee high productivity and farm income.

**Seed Treatment.** Before planting, soak the seeds in fungicide solution for 6 to 10 hours using the recommended fungicides (Table 3). Then drain and incubate the seeds in a warm, moist place for not more than 12 hours.

**Method of Planting.** For typical upland, well-cultivated field, hill-drop three to four seeds per hill in the prepared furrows then cover the seeds thinly with soil. Follow the recommended distances.
For minimum tillage (direct dibbling or furrow slicing method), dibble the seeds 6 to 8 cm deep using a pointed stick. Use a string as row guide if the preceding rice crop was planted randomly, otherwise, use the rice rows as guide.

**Spacing/Plant Population.** The maintenance of proper plant population is important in ensuring high seedcotton yield. The desired plant spacing/density for the various agro-climatic growing conditions in the country is shown in Appendix Table 1. In saline areas and where planting could not be done within the prescribed schedule, cotton transplanting can be practiced. Raise the seedlings in soil blocks or other appropriate media in 30-40 days. Set the transplants following the desired spacing using a soil molder/digger or in furrow slices.

**Seeding Rate.** Seeding rate depends on the recommended plant density and seed germination percentage. Late planting usually requires higher seeding rate. Generally, the recommended seeding rates are as follows:

- Luzon - 15-20 kg/ha
- Visayas - 10-15 kg/ha
- Mindanao - 10-15 kg/ha

**Initial Irrigation.** Irrigate the field after planting to provide adequate soil moisture to support the germinating seeds.

**Step 4. Replanting and Thinning**

Replanting

Replant missing hills within 10 to 22 DAP. Delayed replanting results in uneven plant stand and maturity, which make it difficult to control pests and diseases.

Thinning. Thin the plants within 14 to 27 days after planting (DAP), leaving two vigorous plants per hill. Delayed thinning results in weak and lanky plants.

**Step 5. Off-barring, Side-dressing and Hilling-up**

**Off-barring.** Intertillage cultivation during the growing season controls weeds, provides good aeration, and hasten water infiltration when it rains or during irrigation. At 22-27 DAP, pass a spike-tooth harrow in between the furrows. Off-barring or hand-hoeing at 35 DAP.

**Side-dressing and hilling-up.** At 42-47 DAP, sidedress fertilizer in band 3-5 cm away from the plant base, then hill-up immediately to cover the fertilizer with the soil. This method minimizes loss of N through volatilization. If the soil is dry, irrigate immediately after hilling-up to dissolve the fertilizer.

In case of over vegetativeness, sidedress with N may be unnecessary.

Off-barring and hilling-up should be done if minimum tillage without mulch is employed, especially in areas where weeds are prevalent and furrow irrigation is practiced.
Step 6. Irrigation

Irrigation may be done through the furrow or hose method, depending on water source and economics of application. The hose method is recommended when water for irrigation is scarce. This is done by carrying the hose (usually 1-¼ plastic pipes) and directing water discharge to the rows or hills.

To help reduce the frequency and amount of water application, mulch the field with suitable materials (usually rice straw). However, this is recommended only if mulching materials are abundant and cost-free.

Irrigation should be done during the crop's critical stages, i.e., on the 6th, 8th, 11th, and 13th week after planting. If the above schedules are not applicable, irrigation may be based on mid-day wilting of the crop and soil-feel method as it relates to the available soil moisture. Based on feel and appearance of the soil 15 cm from the surface, irrigate when the soil appears dry and will not form a ball with pressure on coarse and light soils, somewhat crumbly but will hold together with pressure on medium soils, or somewhat pliable but will form ball with pressure on heavy soils.

In addition, the following physiological indications for water deficiency may be used as guide on time to irrigate:

- Temporary wilting at noon; leaves turn to pale green;
- Inhibition of apical growth: there is rosetting of shoots or shortened internode;
- Reddish coloration of the stems approaching the shoots tip or the green soft part of the shoot tips is less than 4 cm;
- Flower garden appears numerous flowers at the upper part in rosetted plants.

Step 7. Pest Management

Insect Pest Management. The major insect pests of cotton are bollworm, leafhopper, flowerweevil and pink bollworm. Uncontrolled, damage to crops can be substantial not to mention the high cost of controlling them. Proper pest management, therefore, is necessary to ensure a good yield.

Insect Pest Monitoring. Insect pest monitoring is vital for successful pest management. It guides and gives timely information regarding the presence of pest, thus allowing an intelligent decision whether insecticides are needed or not. Survey 20 randomly selected plants for the presence or absence of pests weekly starting from 21 to 96 DAP. Spray the recommended pesticides when the critical pest level (CPL) is reached (Table 4).

To check if insecticide used is effective or not against targeted insect pests(s), conduct an insect survey 2-3 days after spraying.

Spray Application. For an effective and efficient chemical pest control, the following should be considered:
Appropriate Nozzle. Select the appropriate nozzle to reduce the volume of spray solution per hectare. A nozzle with the finer droplet size is desired. If a double nozzle is attached to the sprayer, close one nozzle to reduce the discharge rate by half. If a technoma lance is available, use the 10:2 nozzle combination and the application rate is approximately 100 liters per hectare. The CRDI low volume nozzle has a similar discharge rate as the technoma lance, that is, minimum of 100 droplets per cm² above the plant canopy;

Horizontal Nozzle Direction. For better distribution of spray droplets in the canopy, the nozzle must point forward or sideways (horizontal position) rather than downwards (vertical position).

Nozzle Height. Maintain a nozzle height of at least 30 cm above the crop canopy.

Constant Pumping Pressure. Pump the sprayer slowly and constantly to ensure uniform spray. It is also less tiring and minimizes wear of the pump cylinder.

Correct Amount of Insecticide Per Tank Load. The list of insecticide recommendation in Table 5 presents the correct array of recommended insecticides on insect monitoring as well as the correct amount to be mixed per tankload.

Remember to mix thoroughly the insecticide with the water inside the sprayer. To avoid operator contamination at the same time improves spray distribution, use wind blowing across the field as much as possible. If there is a crosswind, the spray mist will be blown away from the operator to the plants of the nearest downwind rows. No pesticide group should be used longer than four weeks at a time to prevent the development of resistant pest population. Unfortunately, pyrethroids, being the most effective chemical are the fastest to cause resistance development among insects. Hence, they should be used judiciously only for one bollworm generation per cropping season and should not be used during early crop stage so as not to expose insects to too much pressure. They may also cause resurgence of spider mites and aphids.

Organo-chlorines, e.g. Seven XLR can be alternated with Endosulfan while Methomyl may be used at a later stage because of observed phytotoxic effect. Nevertheless, Methomyl is effective because it is systemic and with ovicidal activity. Carbamates are generally safer to handle, with low mammalian toxicity and shorter residual life.

Other general recommendations for pesticide use:

Delay the first pesticide application for as long as possible. This give predators chance to help reduce bollworm population which is still the most destructive insect pest. Controlling bollworm with chemicals alone is very expensive.

Avoid using dining tablespoon in measuring pesticide dosage as this poses a serious hazard to health. Moreover, the assumption that one tablespoon is equivalent to 10 ml is incorrect. Tablespoons come in various sizes and usually contain less than 10 ml. Instead, use graduated and/or calibrated measuring cups.
The most effective pesticide can work only if it is applied properly. Dirty, faulty or damaged spray equipment, as well as careless or untrained operators, renders many spray applications futile.

**Other Effective Means of Pest Control**

**Leafhopper** - The use of resistant varieties such as CRDI-1 and UPL-C2 could lessen leafhopper infestation.

**Bollworm** - *Trichogramma chilonis* integrated with chemical is recommended whenever possible because it parasitizes eggs of *H. armigera*. This reduces chemical sprays and also preserves predators. Weekly releases of 67,000 Trichogramma per hectare per release at 2 releases/week commence at 45 DAP when adult moths of *H. armigera* are presumed to deposit eggs. Forty strips of paper containing the parasitoids are placed strategically well distributed in the cotton field by clipping the Trichogramma strips at the upper side of the upper 3rd of the leaf. Thirty minutes after emergence, the parasitoids actively search for their hosts.

Single rows of trap crops such as tomato, tobacco and corn planted at an interval of 15-20 rows of cotton can be employed to divert bollworm away from cotton. The trap crop is regularly checked and the bollworm are either handpicked or sprayed with appropriate insecticides.

**Flowerweevil** - The cotton crop is most susceptible to flowerweevil damage during the first six weeks from flowering, approximately two-and-a-half flowerweevil generations. One generation of the flowerweevil lasts roughly for two-and-a-half weeks.

Several control practices are capable of controlling the flowerweevil problem:

- **Close season planting** - Planting all fields within the shortest possible time is the best way to minimize the problems caused by flowerweevil. A cotton cluster planted within four weeks allows flowers to escape damaging population of flowerweevil.

- **Field sanitation** - Cutting and burning plant residues after harvest kill most of the remaining insect pests and deprive the few survivors of food source during the cotton off-season.

- **Trap crop** - Okra planted in borders of cotton field also serves as trap crop for flowerweevil. Infested okra flowers are collected and the weevil inside are killed and burned.

- **Preservation of natural enemies** - Red ants are the most important natural enemies of flowerweevil. To avoid killing the red ants early, insecticide should be applied only when absolutely necessary.

- **Physical destruction of flowers damaged by flowerweevil** - Inspect the presence of flowerweevil or damaged flower. Flowers detected to contain a weevil or show typical damage symptoms should be collected and destroyed.
by squeezing them between the fingers and burned. As more than 70 percent of infested flowers during the early infestation already contain eggs, this practice should be done continuously for about two weeks from start of flowering.

**Flower to Flower Dusting** - Dusting of flowers starting at 60 - 97 days after planting gives effective and economical way of reducing flowerweevil population.

**Pink Bollworm.** This is one of the word's most devastating insect pests. It has led to the breakdown of the cotton industry in several countries and is now also spreading in the Philippines. Like the flowerweevil, pesticides cannot easily control pink bollworm. Thirty minutes after its egg hatch, the larvae hid inside the "rosetted" flowers and feed inside the bolls where they are out of reach of spray. The same cultural control methods described under the flowerweevil section can be used to control pink bollworm. In addition, there are two or more helpful tips to follow:

Sun drying seedcotton is important to maintain high quality fiber. At the same time, the temperature inside the seedcotton during sun drying reaches levels unbearable for pink bollworm.

If a high incidence of pink bollworm larvae is detected in the ginnery, fumigate the agricultural seeds and sometimes even the industrial seeds to reduce the number of insect pests carried over to the next crop season.

**Spiny Bollworm** - Occasionally, spiny bollworm is observed to attack the tips of young cotton plants. This early damage does not cause economic losses. On the contrary, heavier boll loads may be observed on plants infested with spiny bollworm during the vegetative stage. This is due to the formation of several boll-bearing branches for every tip destroyed. The damaged cotton plants are delayed in their maturity by several days. However, this delay is normally shorter than that caused by replanting. Normally, therefore, no control measures are recommended against early attack of spiny bollworm. A tentative, conservative threshold for it can be treated with systemic pesticides if more than 20% of the plant tips are damaged.

**Aphids** - Aphids frequently attack young cotton plants. The characteristic damage is the "cupping" of leaves. Although this impedes the development of some individual plants, the performance of the cotton field as a whole is rarely affected. In fact, early aphid populations usually break down after a while due to many factors that naturally control aphid populations. Moreover, aphids serve as a "staple food" of some of the most numerous insect predators. Ants, for example, "milk" aphids to obtain their honey dew. In return, ants provide the best known natural protection against flowerweevils and bollworms.

At harvest time, high aphid populations may cause damage to the cotton fiber. Their honey dew will make the fiber sticky and cause discoloration due to sooty mold. Applying systemic pesticides is then appropriate to reduce aphid population.

A tentative treatment threshold is, "treat if equal or greater than 15 percent of the highest open bolls are with honey dew".
Weeds Management

Since there is no single weed control measure appropriate in all situations, weed management is an integration of compatible weed control strategies that provides an effective and economical control of weeds with minimum negative impact on the environment.

The following are suggested weed management approaches in cotton.

Approach 1

Prepare the field thoroughly by one to two plowings and two to three harrowing.

At 22-27 days after planting (DAP) pass a spike tooth harrow in between the furrows.

In weedy areas with high labor cost, herbicide application (see Table 3) is resorted to. Apply:

Pre-emergence herbicides like Pendimethalin (Hebadox 330 EC), Diuron (Karmex 80 WP), Pendimethalin (Prekill 330 EC) or Diuron (Diuron 80 WP) and/or

Early post-emergence herbicides like Fluazifop-butyl (Onecide 15 EC) or Sethoxydim (Nabu 20 EC) at 3 to 6 leaf stage of grass weeds. These are recommended in areas with predominant grass weeds. Onecide and Nabu do not control broadleaves and sedges.

Off-barr weeds at 30-35 DAP and hill-up at 42-47 DAP.

Remove weeds left within the rows by handweeding up to 60 DAP.

Approach 2

Cut rice stubble close to the ground after rice harvest.

Clean the field of weeds by handweeding or weed slashing or spray with glyphosate (Round-up or Power)

Dibble cottonseeds following the prescribed plant spacing. Spread rice straw about 5 cm thick between furrows, providing an open space for the emerging cotton seedlings.

When the seedling had emerged about 6 cm tall, push the rice straws towards the base of the seedling so that the whole area will be covered with mulch.

Remove weeds that went through the mulch by handweeding at 25 to 60 DAP.

Disease Management
Major Diseases of Cotton. There are four major diseases of cotton in the Philippines. They are as follows: Damping-off, caused by *Rhizoctonia solani* Kuh and *Sclerotium rolfsii* Sacc., Fusarium wilt caused by *Fusarium oxysporum f. sp. vasinfectum*, boll rot caused by *Diplodia gossypina* Cke. and bacterial blight caused by *Xanthromones malvaceaum*.

Management: a) thorough land preparation, b) use of resistant variety such as UPL-C2 and CRDI-1, c) use of fungicide as seed treatment, d) rotation of cotton with rice, corn, sorghum or other crop not affected by *Fusarium oxysporum f. sp. vasinfectum* to reduce inoculum level, e) follow the proper distance of planting to allow good aeration, f) avoid applying too much nitrogen to prevent excessive growth, g) control insects which attack the bolls or injure on the boll surface facilitating infection, h) seeds for planting should be taken from disease-free fields, i) remove and burn infected plants.

**Step 8. Harvesting and Post-harvest Practices**

**Harvesting.** Bolls are ready for harvest 3-4 days after bursting. At this time the bolls are not only physiologically mature but also dry. These bolls give the highest quality seedcotton. Harvesting bag like flour scale or bamboo crate should be used to avoid polypropylene plastic (“PP”) contamination.

**Drying and packaging of Seedcotton.** Generally, however, sun drying for 1-2 days after harvesting is recommended to reduce the moisture content to 10-12%. Aside from ensuring good quality fiber, sun drying also kills pink bollworm larvae in the seedcotton.

**Use only jute sacks or other packaging materials of flour sacks.** Plastic sacks and string cause contamination of the lint resulting to reduction in quality and price.

**Cutting/uprooting and burning of debris.** After the last harvest, all the plants must be either cut or uprooted and burned. A tractor-drawn plow may also be employed to plow under and incorporate the cotton stalks in the soil. This kills insect pest present and thus prevents their build-up. Plant debris turned-under by deep plowing returns organic matter to soil.