Region 02

AGRI Pinoy

CORN TECHNOGUIDE

DEPARTMENT OF AGRICULTURE
Regional Field Office No. 02
Tuguegarao City, Cagayan

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FOREWORD

The Cagayan Valley Region plays a very crucial role in the country's corn production. Consistently and among all regions, we are leading as we share about 21% of the total national production.

The region supplies the bulk of Metro Manila's corn requirements. Eighty-five percent (85%) goes out of the region and a very small portion is milled and used for our own consumption. Our corn is also absorbed by Central Luzon, Southern Tagalog and Ilocos Region because most of the livestock and poultry industries and feed mills are found in these areas.

While we recognize the urgency of ensuring increased production to attain food security, we cannot neglect the fact that one of the immediate concerns of the department is to improve the quality of corn grains. I believe this can be achieved through the introduction of appropriate production and postharvest technologies to our farmers.

In support to a meaningful technology extension, this technoguide has been updated to address the needs of extension workers, policy makers, researchers, traders and farmers especially in these present times.

I, therefore, want to acknowledge the selfless efforts of our technical staff and researchers who shared their expertise in coming up with this very valuable material.

LUCRECIO R. ALVIAR, JR., CESO III
Regional Executive Director

SIGNS, SYMBOLS AND ABBREVIATIONS

Signs and Symbols

°C	-	degree (s) centigrade
/	-	per
%	-	percent
P	-	peso (s)
-	-	to
$	-	dollar (s)
&	-	and
”	-	inch
pH	-	degree of acidity/ alkalinity

Abbreviations

AESA	-	Agro-Ecosystem Analysis
a.i	-	Active ingredient
BAS	-	Bureau of Agricultural Statistics
BFS	-	Balanced Fertilization Strategy
cav	-	cavan (s)
cm	-	centimeter (s)
DAP	-	day (s) after planting
DAS	-	day(s) after silking
Fig	-	figure (s)
g	-	gram (s)
ha	-	hectare (s)
HP	-	horse power
hr	-	hour (s)
HYV	-	high-yielding variety
INM	-	integrated nutrient management

SIGNS, SYMBOLS AND ABBREVIATIONS

IPM	-	integrated pest management
K	-	potassium
kg	-	kilogram (s)
L	-	liter (s)
LGUs	-	Local Government Units
m	-	meter (s)
Mg	-	magnesium
ml	-	milliliter
mm	-	millimeter (s)
mo	-	month
Mo	-	molybdenum
MT	-	metric ton (s)
N	-	nitrogen
NGOs	-	Non-Government Organizations
OPV	-	open-pollinated variety
P	-	phosphorus
pbb	-	parts per billion
sq m	-	square meter (s)
STK	-	soil testing kit
S	-	sulfur
t	-	ton (s)
tbsp	-	tablespoonful (s)
tsp	-	teaspoonful (s)
W	-	wheel
w/	-	with
yr	-	year
Zn	-	zinc

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Cagayan Valley (Region 2) is geographically located at the northeastern part of mainland Luzon covering an area of about 26,858.79 sq km making it the fourth largest region in the Philippines.

It is composed of five provinces namely Cagayan, Isabela, Quirino, Nueva Vizcaya and Batanes which abound with rich natural resources.

Region 02 is primarily agriculture-based and corn farming is one of the major sources of livelihood.

Over the years, it has played a very significant role in taking the lead towards agricultural development and food security, both local and national.

In the entire country, Region 02 is consistent top corn producer and accounts for 21% of the country's total corn production.

In 2009, a total of 417,121 ha were harvested in the Region. The grain yield for white corn is about 2.57 t/ha and 4.02 t/ha for yellow corn.

Table 1. Harvested area (ha) and production (mt) of corn in Region 02, CY 2009

PROVINCE	WHITE CORN			YELLOW CORN			TOTAL		
	Area Harvested (ha)	Production (mt)	Average Yield (mt/ha)	Area Harvested (ha)	Production (mt)	Average Yield (mt/ha)	Area Harvested (ha)	Production (mt)	Average Yield (mt/ha)
Cagayan	12,749	28,336	2.22	82,135	307,268	3.74	94,884	335,604	3.54
Isabela	14,244	39,152	2.75	257,599	1,012,856	3.93	271,843	1,052,008	3.87
Nueva Vizcaya	1,275	3,304	2.59	14,399	60,050	4.17	15,674	63,354	4.04
Quirino	185	506	2.74	34,535	146,726	4.25	34,720	147,232	4.24
Regional Total	**28,453**	**71,298**	**2.57**	**388,668**	**1,526,900**	**4.02**	**417,121**	**1,598,198**	**3.92**

Source: BAS Data, 2009

White corn accounts about eight percent (8%) of the corn areas of the region. It is a staple food particularly in Northern Isabela (Cabagan, Sto. Tomas, San Pablo, Sta. Maria) and Southern Cagayan (Alcala, Amulung, Enrile, Tuguegarao, Peñablanca, Solana).

Yellow corn is commercially used as animal feeds. It is also a good source of starch, derivatives for oil, paints, fibers and other industrial uses. Other by-products of corn include corn flour, syrup and sugar.

Glutinous corn grown as green corn, either boiled or roasted, is a popular snack and can be cooked as soup or with vegetable. Matured glutinous corn grains are processed and sold as "*cornik".*

In terms of nutritive value, corn is a good source of Vitamin A. It also contains high amount of minerals such as calcium and phosphorus.

With the country's goal of attaining food security through increased production and improved quality of corn grains as well as ensuring increased farmers' income, the Department of Agriculture, Regional Field Office No. 02 recognizes the need to update technicians and farmers of the latest location-specific production and postharvest technologies. Hence, this technoguide.

Climatic Requirements

The predominant climate in Region 2 is Type III (See Figure 1). It is characterized by no pronounced wet season but relatively dry from February to April. But due to climate change, there was a significant change which extends the dry months up to June.

Planting season in the region generally starts early part of April and ends at June for the wet season (WS), and October to December for the dry season (DS). Soil moisture is a major requirement to high corn production. However, the optimum rainfall requirement is 400mm to 600mm distributed throughout the growing period. Excessive water and drought are both detrimental in growing corn. Higher yield can be expected during the DS when soil moisture is not limiting.

Figure 1. Climate Map of the Philippines based on the Modified Coronas Classification.

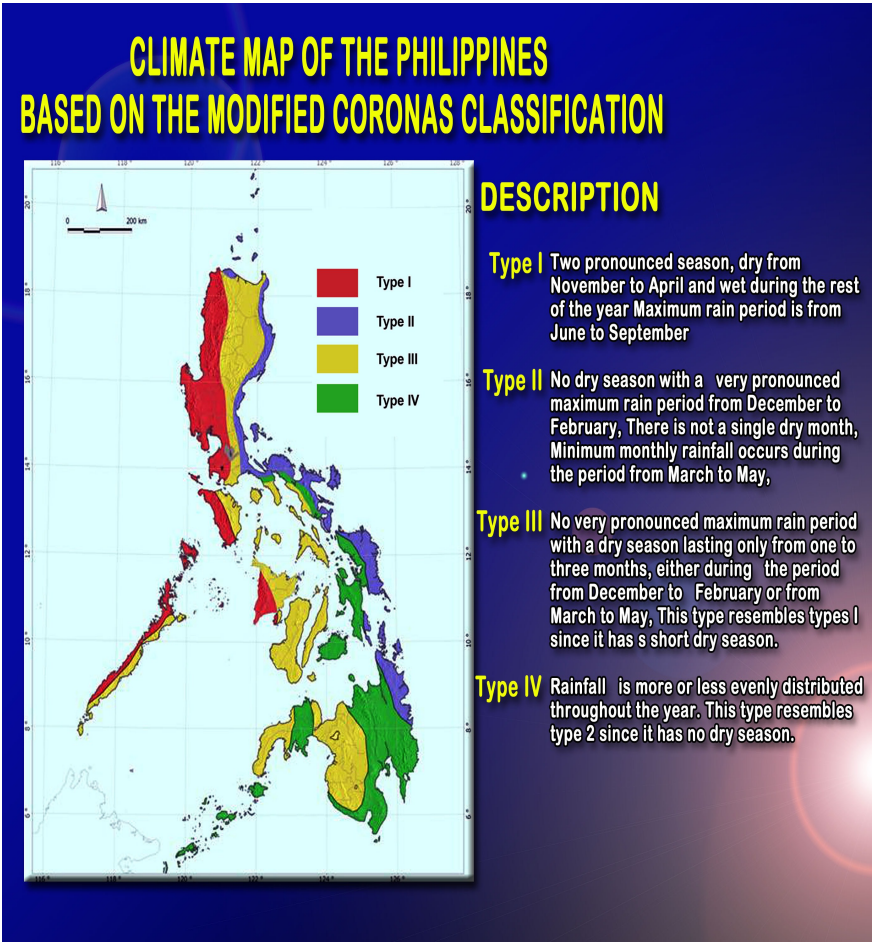


Figure 2. Climatic Map of Region 02.

Soil Requirements

Soils that are friable with high moisture retention capacity, high organic matter content and a pH value ranging from 5.5-7.0 are suitable for corn production. Corn can also be grown in areas with pH below 5.4 but requires application of agricultural lime and other recommended soil ameliorants. A well-drained area with a texture of silt-loam or loam type is also preferable.

Soil Sampling and Analysis

Soil laboratory analysis is conducted to determine the fertilizer recommendation to be applied. The result of the analysis is valid up to three years.

Techniques

1. Make a detailed map of your farm.
2. Determine sampling points considering the following: topography, crops planted, soil color/texture and previous fertilizer applied.
3. Hand-weed the sampling area.
4. Dig a V-cut hole at approximately 8-12 inches deep.
5. Shave a uniform soil slice – 1 inch thick.
6. Trim longitudinally both sides of soil slice and save the 1-inch wide center portion as sub-sample
7. Place all collected sub-sample in a clean plastic bag to make up a composite soil sample.
8. Label samples, including the following information:
   - Name of Farmer/Owner
   - Address/Location of Farm
   - Area Represented (Ha.)
   - Crops to be planted
   - Previous fertilizer applied
9. Submit samples to the soils laboratory or to LGU office/AT's

Note: Additional information about soil sampling and analysis is discussed in Appendix 3 (page xx, at the back).

Soil Laboratory Analysis

Soil analysis is one of the diagnostic techniques for determining the nutrient supplying power of the soil. This method uses chemicals and laboratory equipment to determine accurately the nutrients present in the soil.

Results are interpreted using a table of nutrient requirement *(See Table 2)* which serves as guide for the formulation of a fertilizer recommendation. Data on said table are established through field trials and updating done through the conduct of calibration studies.

Table 2. 2011 Updated Nutrient Requirement Recommendation based on Soil Analysis

A. Hybrid Corn

Ranges of Soil Test Result	Nutrient Requirement (Kg / ha)		
	N	P	K
Low	120	60	60
Moderately Low	100	40	45
Moderately High	80	20	30
High	60	7	7

B. OPV

Ranges of Soil Test Result	Nutrient Requirement (Kg/ha)		
	N	P	K
Low	80	60	60
Moderately Low	60	40	45
Moderately High	40	20	30
High	20	7	7

Mode of Fertilizer Application for:

1. *Organic Fertilizer*
   Broadcast ten bags organic fertilizer per hectare during the last harrowing before furrowing.

2. *Inorganic Fertilizer*
   1st Application: Apply all P & K and one-half of the N fertilizer in a band, 5 cm to the side and 5 cm below the seed during planting.

   2nd Application: Sidedress the remaining half of the N fertilizer when the plants are four weeks old or when the plants are knee high (30-48 cm).

Liming

The most favorable pH range for plant growth is from slightly acidic to neutral or a pH which ranges from 6.0-7.0. Under this condition, the soil becomes most favorable for the availability of nutrients and microbial activities including nitrogen fixation by bacteria and faster decomposition of organic matter which are essential to plant growth.

Although plants differ in their pH preferences and/or tolerance to soil acidity, acidic soils must be limed 6.0-7.0 pH.

The critical pH level is 5.4. Below this range, lime should be applied to neutralize the acidity of the soil. The amount of lime to be applied depends on the soil type and pH value *(See Table 3).*

Table 3. Lime Recommendation based on Soil pH and Soil type

pH	LIME REQUIREMENT (mt/ha)				
	Sandy	Sandy Loam	Loam	Silt & Clay Loam	Clay
4.0 - 4.4	3.0	3.5	4.5	6.0	7.5
4.5 - 4.9	1.5	2.5	3.2	4.2	5.2
5.0 - 5.3	1.0	1.5	2.0	2.5	3.0

Land Preparation

For broad and river flood plains including slight undulating hilly areas, prepare the land thoroughly for uniform seedling emergence and good root development. Plow at a depth of 15-20 cm when soil moisture is right. Deeper plowing however is better for root development. Harrow the field immediately after plowing preferably two to three times to break the soil clods with an interval of one week for effective weed control.

If a 4-wheel drive tractor with a trailing harrow is used, one to two passings at one week interval is sufficient to prepare the area before furrowing and planting.

In areas of continuous farm mechanization, deep plowing with the use of chisel plow or sub-soiler is recommended every 2-3 years to break the hard pan.

In hilly areas, the following soil conservation practices are recommended:

1) Sloping Agricultural Land Technology (SALT)
2) Contour farming
3) Reduce the use of glyphosate herbicide
4) Zero to Minimum tillage

Seed/Varietal Selection

Select corn varieties that are high yielding, resistant to insect pests and diseases and adaptable to the climatic conditions of the area. For white flint corn, select a variety with good eating quality and high in protein content *(See Table 4).*

Table 4. Recommended Corn Varieties in Region 02.

Variety/ Hybrid (Conventional/ GMO)	Yield (t/ha)	Maturity	Resistance			Grain Color	Corn Type
			Cornborer	Earworm	Foliar Disease		
IES Cn 5	5.00	95-100	R	R	R	Yellow	OPV
IES Cn 7	5.77	95-101	R	R	R	Yellow	OPV
IES 89-06	5.75	92-97	MR	MR	MR	White	OPV
IES 89-10	5.52	95-100	R	R	R	White	OPV
IES 89-12	5.48	95-100	R	R	R	White	OPV
IES 09-02	5.30	95-101	R	R	R	White	OPV
IES Glut # 2	4.00	95-100	R	R	R	White	OPV
IES Glut # 3	4.50	95-100	R	R	R	White	OPV
IES Glut # 4	3.80	95-100	R	R	R	White	OPV
IES Glut # 6	5.31	98	MR	MR	MR	White	OPV
IES Glut # 7	5.54	98	MR	MR	MR	White	OPV
CW 851	7.91	104	R	R	R	Yellow	3X
TSG 398	7.79	102-105	R	R	R	Yellow	3X
TSG 361	7.21	109	R	R	R	Yellow	3X
TSG 81	7.24	105	R	R	R	Yellow	3X
DK9132RRYG	13.00	120-125	R	R	MR	Yellow	SC
DK9132RRYG2/	13.00	120-125	R	R	MR	Yellow	SC
P30B80	7.05	105	R	R	R	Yellow	SC
P 30T80	5.05	105	R	R	R	Yellow	SC
P3482YR	7.10	103	R	R	R	Yellow	SC
PAC 105	6.69	106	R	R	R	Yellow	SC
Healer 101	7.93	103	R	R	R	Yellow	3X
P 30D44	6.97	101	R	R	R	Yellow	3X
Bioseed 9899	7.21	104	R	R	R	Yellow	3X
Ghen 703	8.24	103	R	R	R	Yellow	3X

Note: DK9132YG2/RRC2 also has resistance to Common cutworm (Spodoptera litura). These listed varieties are available at CVIARC, San Felipe, Ilagan, Isabela at an affordable price.

Legend:

R - Resistant
MR - Moderately Resistant
HR - Highly Resistant
OPV - Open Pollinated Variety
SC - Single Cross Hybrid
3X - 3-way Cross Hybrid
CB - Corn borer
EW - Earworm

Planting

Plant certified hybrid seeds to attain optimum yield of 8 t/ha with a plant population of at least 75,000 plants/ha. This requires 22-24 kg of seeds with a planting distance of 18-20 cm between hills and a furrow spacing of 70 cm.

For OPV, 20 kg certified seeds (white corn or glutinous variety) is enough to attain an optimum plant population of at least 50,000 plants/ha with a planting distance of 25 cm between hills and a furrow spacing of 75 cm. For a bigger green corn ear-size, use a wider spacing of 30 cm x 75 cm.

Before planting, inoculate the seeds with BIO-N at the rate of one pack per 3 kg of seeds. (*See Appendix 4: How to Apply BIO-N*) Plant one seed per hill after setting the furrows. Cover the seeds with 3.5 cm soil.

Inter-row Cultivation

Cultivation improves soil tilth, aeration and suppresses the growth of weeds. If weeds are dominant or prevalent at 15-20 days after planting (DAP), start cultivation by off-barring using animal-drawn plow.

Hilling-up is done 21-30 DAP which coincides with side dressing of nitrogen fertilizers. During the dry season when soil moisture is limited, hilling-up is optional to conserve the soil moisture.

Integrated Nutrient Management (INM)

For areas without soil laboratory analysis, follow the fertilizer recommendation based on Balanced Fertilization Strategy (BFS) .

Apply all the needed phosphorus, potassium and one-half of the recommended amount of nitrogen and at least ten bags per hectare of organic fertilizer in the furrows as basal. If moisture is sufficient at 21-30 DAP, sidedress the remaining half of the nitrogen at least 4-5 centimeters away from the base of the plant.

During the dry season cropping, apply all the recommended amount of fertilizers (organic and inorganic) while there is still sufficient soil moisture at planting. In case moisture is available at vegetative stage and if plants show nitrogen deficiency, supplemental application of one to two bags of urea is recommended. However, if supplemental irrigation is available, follow the application of fertilizer during the wet season cropping.

Water Management

If soil moisture is not sufficient, supplemental irrigation is necessary in any growth stage of the crop. This is important during reproductive stage to ensure flower and silk synchronization, pollination and ear development. Irrigation may be applied through flushing or overhead method.

Integrated Pest Management (IPM)

IPM is an ecologically-based strategy in the management and prevention of pests. Analysis of the agro-ecosystem and action revolves around three basic principles:

1. Grow a healthy crop by using resistant varieties, appropriate nutrients, soil, water and weed management;
2. Conserve beneficial predators and parasites; and,
3. Observe the field regularly to determine appropriate management action necessary to produce a profitable crop through the Agro-Ecosystem Analysis (AESA).

Training on IPM- Farmers' Field School and attendance to

method demonstrations by farmer-leader extensionists (FLEs) is necessary to fully understand the concept. Training Schedules are usually coordinated with the office of the Municipal Agriculturist in your areas.

A. Weeds and Weed Management

Weeds are plants growing in the place where they are unwanted. They will compete for soil moisture, nutrients and space with the desired crop. The most destructive period of weed occurrence is during the first 30 days growth of corn.

Weeds are effectively controlled by a combination of two or more management approaches. The type of combination depends on weed species present and density in the locality. The most practical approach, however, is two times cultivation (off-barring and hilling-up) followed by spot weeding if conventional varieties are used.

In areas where “aguingay” (*Rotboella cochinchinensis)* predominates, this could be controlled by the use of recommended pre-emergence herbicides. Spraying of 2-4D herbicide is recommended for broadleaf weeds like “mara kamote”(*Ipomoea triloba),* “kalunay” or “kulitis”*(Amaranthus sp.)* which grow very fast during the wet season.

For genetically modified organism (GMO) varieties (glyphosate-ready), follow the manufacturer’s recommendation.

Tips in applying herbicides for conventional hybrid and OPV varieties of corn:

a. Apply pre-emergence when soil surface is moist. Do not disturb the soil surface after application.
b. Apply accurately. Applying an amount less than the required dosage may mean unsatisfactory weed control while an overdose is hazardous to the crop.
c. Observe proper and safe methods of handling and spraying herbicides.
d. Post-emergence herbicides should be applied before reproductive stage. For paraquat or highly contact herbicides, it should be sprayed directly to the weeds. Avoid spray solutions to contact with the leaves of corn.

B. Insect Pest Management

Corn plants are being attacked by insect pests during their entire growth period. Failure to manage can cause yield reduction and poor grain quality. Following are the various kinds of insect pests and their management/control.

Table 5. Insect pest of corn, nature of damage and pest management.

Insect Pest	Nature of Damage	Pest Management
1. Corn borer	a) pinholes on leaves . b.) boring on stalks, base of tassel or ear shanks. c) granular excreta or frass on perforation. d) broken stalks. e) clumping of tassels. f) partial destruction of cobs. g) dropping of cars in severe cases.	a) Synchronous planting. Plant at the same time with other farmers. b) Biological control using trichogramma and earwigs. c) Sanitation. Cut and burn or plow under stubble after a corn borer infestation. Burn or bury removed tassels or give them to farm animals as feeds. d) Detassel or remove the tassels of 75% of the corn plants, before pollen shed. Follow a 1:3 ratio of tasseled and detasseled rows. Always remove tassel of first row. e) Use of GMO corn with Bt

Figure 3: Corn borer

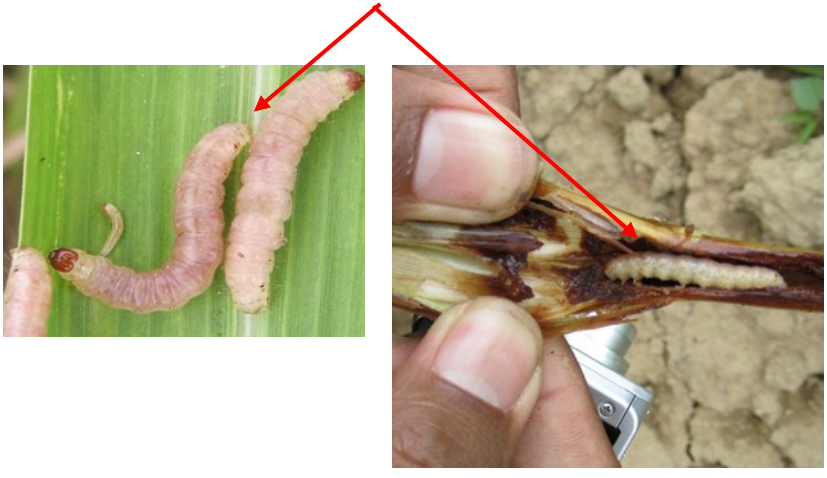


Table 5. Insect pest of corn, nature of damage and pest management.

Insect Pest	Nature of Damage	Pest Management
2. Corn Earworm	a) Lines of feeding holes on leaves after they unfold at whorl stage. b) Cut silk and hole at opening of ears from silking to soft dough stage.	a) Avoid planting crops like tomato, tobacco and cotton that serve as alternate host to corn earworm near cornfield. b) Biological control using Trichogramma and earwigs

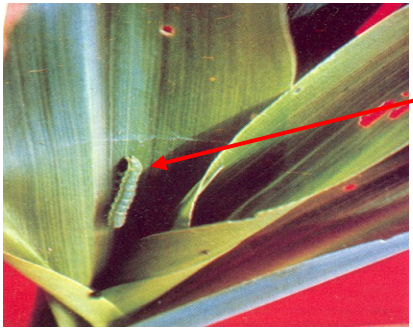


Figure 4: Corn Earworm

Insect Pest	Nature of Damage	Pest Management
3. Corn Seedling Maggot	a) yellowing of younger leaves and rotting of tissues b) Infested seedlings show stunted growth	a) Avoid late planting b) Practice clean culture including removal of alternate weed hosts

Table 5. Insect pest of corn, nature of damage and pest management.

Insect Pest	Nature of Damage	Pest Management
4. White Grub	a) Stunted and discol-ored seedlings b) Rootlets eaten up causing wilting and eventual death of corn	a) Prepare land thoroughly before seedling. b) Handpick grubs during land preparation

Figure 5: White Grub

Insect Pest	Nature of Damage	Pest Management
5. Army worm	a) leaf margins irregularly eaten b) In serious cases, whole plants are stripped bare leaving only the midrib	a) Practice clean culture

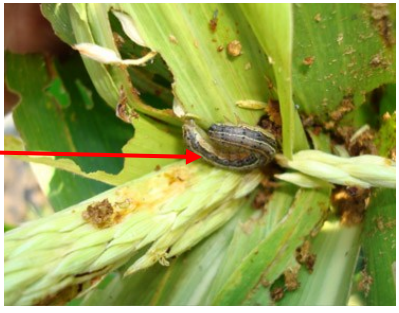
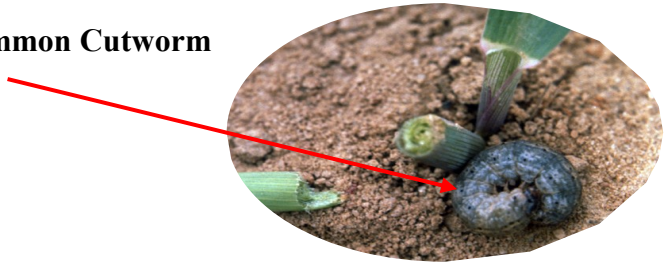


Figure 6: Army Worm

Table 5. Insect pest of corn, nature of damage and pest management.

Insect Pest	Nature of Damage	Pest Management
6. Common Cutworm	a) young plants completely defoliated b) Cut stem and leaves c) Leaves including veins and midribs almost consumed	a) Practice clean culture

Figure 7: Common Cutworm



Insect Pest	Nature of Damage	Pest Management
7. Corn Aphids	a) stunted growth due to removal of plant sap by colonies of insects weeks before tasseling. b) Corn seedlings may wither and die if infested at early growth stages. c) Leaf surface sooty caused by fungal infection due to heavy deposits of honeydew.	a) Conserve lady beetles and syrphids that prey on aphids, nymphs and adults.

Figure 8: Corn Aphids

Table 5. Insect pest of corn, nature of damage and pest management.

Insect Pest	Nature of Damage	Pest Management
8. Corn plant hopper	a) Stunted growth b) Pre-mature drying of leaves c) Soothy molds growth in the leaves d) Complete drying of plants	1. Continuous monitoring 2. Cultural Methods a. Practice fallow period b. Crop rotation – alternate corn plant ing with root crops and other non-graminae crops c. Plow under corn stubbles to kill remaining eggs, nymphs and adults d. Synchronous planting e. Follow recommended fertilizer requirement f. Increase planting distance (60-70,000 plants/ha) in areas with seasonal occurrence g. Intercropping leguminous plants as harborage of natural enemies 3. Biological Control a. Eggs are parasitized by wasps b. Myrid bugs prey on eggs c. Dragon flies and damsel flies prey on adults d. Spiders and earwigs prey on nymphs and adults e. Lacewing prey on nymphs and adults f. Use of *Metarhizium sp*. 4. Chemical Control a. If nymph and adult population is steadily increasing, apply systemic insecticides using recommended rate b. If there is continuous population build-up, apply contact insecticide again to arrest immigration of winged forms.

Figure 9: Corn Plant hopper

Table 5. Insect pest of corn, nature of damage and pest management.

Insect Pest	Nature of Damage	Pest Management
9. Oriental Migratory Locusts	a) Leaves irregularly eaten b) In serious injury, whole plants sometimes stripped bare, completely defoliated	a) Conduct surveillance and early warning activities. b) Community effort is recommended through handpicking and blanketing c) Control treatment based on observations made in roosting and breeding sites

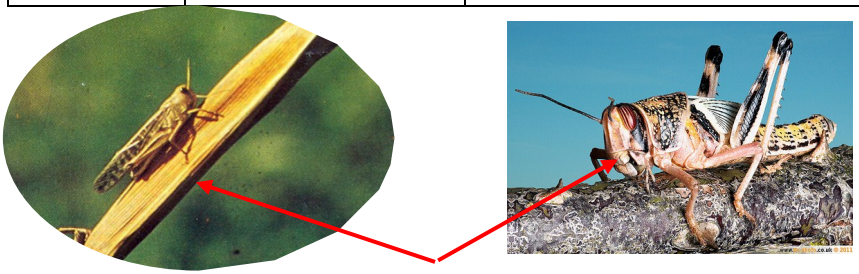


Figure 10: Oriental Migratory Locusts

Insect Pest	Nature of Damage	Pest Management
10. Field cricket	a) Corn seedlings totally cut along the soil surface. b) Damaged roots	a. Thorough land preparation b. Synchronous planting c. Flooding d. Mass application of poison baits -Dehydrated coconut plus insecticides containing metaldehyde, carbaryl or propoxur

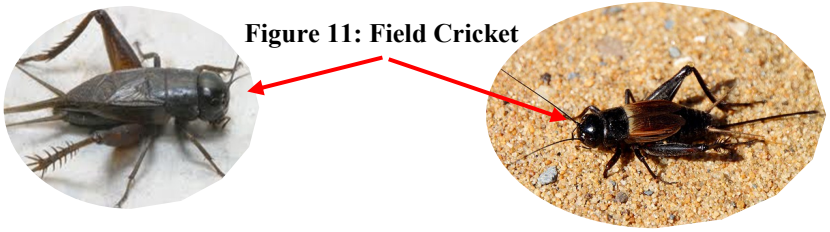


Figure 11: Field Cricket

Table 6. Corn diseases, symptoms and management recommendations.

Disease	Symptoms	Management Recommendation
1. Stalk rot complex	a) Stalk rot starting from the base progressing upward and eventually causing wilting of the lowermost leaves. b) Infected inner tissues of older plants deteriorate and become soft with foul odor, and later, dry, easily disjointed fibers. c) Plants infected at post-tasseling stage may remain standing but exhibit wilting of leaves. d) Wilted leaves at whorl stage can be detached easily from growing point . e) Rotting usually start at the base of the ear.	a) Balance fertilizer application. b) Follow recommended spacing. c) Provide good drainage and improve soil condition through cultivation. d) Avoid root injury during cultivation.

Figure 12: Stalk rot complex

Table 6. Corn diseases, symptoms and management recommendations.

Disease	Symptoms	Management Recommendation
2. Banded leaf and sheath blight	a) Irregular blotches on leaves, stalks and ears. b) Center of patches are straw-colored with distinct brown borders. c) Irregular light to dark – brown fungus lumps known as sclerotial bodies (less than 1 mm diameter) on dead tissues.	a) Follow nitrogen recommendation and plant spacing. b) Plant resistant varieties. c) De-leaf infected leaves, bury or burn to eliminate sclerotial bodies.

Figure 13: Banded leaf and sheath blight

Figure 14: Downy mildew

Disease	Symptoms	Management Recommendation
3. Downy mildew	a) Infected plants show white-yellow streaks first at the base then on entire leaf blade. b) Whitish growth on both sides of the streaks then humidity is high. c) Severely infected plants are chlorotic.	a) Plant resistant varieties b) Treat OPV seeds with metalaxyl (Apron 35 SD) at 2g a.i/kg seeds. Dissolve 2g chemical in 10ml water before mixing with seeds. c) Avoid planting corn in areas near sugarcane, sorghum and in *talahib* areas.

Table 6. Corn diseases, symptoms and management recommendations.

	d) Dwarfing with reduced elongation of internodes. e)Ears and tassels poorly developed in advanced stages of the disease.	d) Plant early and synchronously to minimize heavy infection.

Disease	Symptoms	Management Recommendation
4. Leaf Rust	a) Small and circular brown rusty pustules or blisters on upper and lower surface of leaves. b) Premature drying of leaves in susceptible plants. c) Dwarfing with reduced elongation of internodes. d) Ears and tassels poorly developed in advanced stages of the disease.	a) Plant resistant varieties. b) For seed production apply appropriate fungicides when pustules first appear.

Figure 15: Leaf Rust

Table 6. Corn diseases, symptoms and management recommendations.

Disease	Symptoms	Management Recommendation
5. Leaf Spot	a) Lesions are often yellow to tan in color at early stage. b) Presence of faint watery halo. c) As lesions expand, they become tan to brown and rectangular in shape.	a) Crop rotation b) Use diseased-free seeds or use resistant cultivars c) Proper observance of planting distances d) Proper field sanitation e) Removal and proper disposal of infected plants. Burn infected plant tissues when possible f) Avoid working when plants are wet

Figure 16: Leaf Spot

Figure 17. Corn Nutrient Deficiency Identification Guide

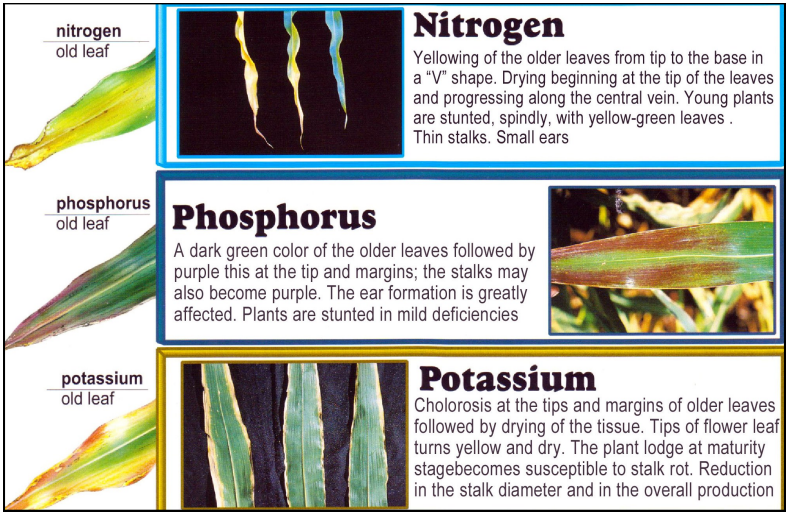


Figure 18. Corn Nutrient Deficiency Identification Guide

Zinc

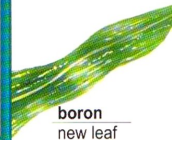
White or yellowish stripes between the main vein and the borders to which necrosis may follow and purple tints may occur. In extreme cases, a shortening of the internodes may take place.

Manganese

Intervein chlorosis on newer leaves. In more severe cases, long white stripes show up in the tissue and the tissue in the middle of the chlorotic area may die and fall off.

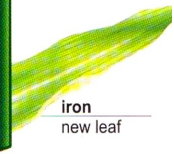
Boron

Elongated white stripes on new leaves. Poor pollination, flower abortion, smaller ears and poor seed formation. Corn seeds bear voids at the silk end. A shortening of the internodes and a smaller stalk diameter.



Iron

Intervein chlorosis starting with the newer leaves at the whole extension of the blade. A reduction in the ear formation. Under severe conditions, the new leaf will turn white.



Copper

The newer leaves become yellowish as soon as they begin to unfold, then the tips bow and bear necrosis. The margins are necrosed. The leaves twist or spiral.

Molybdenum

Small white spots on the larger interveins, leaf bending along the central vein. The manifestation of the visual deficiency symptom of molybdenum is infrequent. However, low nutrient levels at the leaves affect the utilization of nitrogen by the crop.

Table 7. Other environmental factors affecting corn.

Causes	Effects
1. Drought	Upper leaves of young plants roll and dries. In older plants, drought causes Nitrogen deficiency even if enough N was applied. Plants are severely stunted with irregular brown or tan patches of dead leaf tissues. Drying of tassels, poor pollination and unfilled ears.
2. Flood/ poor drainage	Leaves of plants turn yellow and die.
3. Strong Wind	Mutilated leaf tips and edges and dries. Plant completely lodge. Poor pollination and poor ear development.

C. Rodents

High rodent population if not properly managed can cause severe damage to corn crops. Corn crop is susceptible to rodents from newly planted to maturity stages. Stored grains are highly prone to rodent infestation.

The adult female rodent has a gestation period of 21-23 days and can farrow three to four times a year with an average litter of six. The youngs are weaned when they are about three weeks old.

Rodents have poor eyesight but have keen senses of smelling, hearing and touch. Their chisel-like incisors, strong limbs tipped with efficient claws, streamlined body contour and highly developed senses make the rat destructive both during day and night.

Rodents are common in areas where grasses grow thick, near bamboo groves and in weedy uncultivated lands adjacent to cornfields.

Management Recommendations

1. Practice clean culture.
2. Destroy breeding places and related shelters so they will be deprived of habitat conducive for reproduction.
3. Conserve predators like cats, dogs, snakes, and crows.
4. Use rodent-proof grain storage. Install metal sheaths (rodent guards) around each post of elevated storage building. For ground level floors, provide concrete floors and walls, solid doors and screened windows.
5. If there is high rodent population, use acute rodenticides. Sustained baiting with anti-coagulants is an effective and economical method of controlling rodents.
6. Launch a community-wide rodent control campaign.

Tips for effective sustained baiting:

a. Prepare poisoned baits using "*binlid* (*pegpeg)"*, low quality rice or other suitable baits to a chronic-type rodenticides.
b. Start baiting from planting by placing ten baiting stations or locations per hectare strategically placed.
c. Place 6 tbsp full of bait inside each container (baiting station) made of local materials such as empty cans, bamboo sections and coconut husks.
d. Visit the baiting stations twice a week to replace consumed, wet and moldy baits. Place additional baiting stations in places where baits are completely consumed.
e. If population is high, the use of acute poison is advised to effectively suppress the rodents. Conduct pre-baiting for one or two days. If the bait is totally consumed, apply immediately the bait with acute poison.
f. A community mass baiting is recommended.

Tips in handling rodenticides:

Rodenticides are poisons. For safe handling, observe the following precautions:

a. Wear gloves to avoid direct contact with the poison.
b. Wash hands and equipment after mixing.
c. Do not expose the chemical. Replace container cover immediately after use.
d. Mark poison containers.
e. Do not smoke while mixing.
f. Record the location of baiting sites or stations.
g. Do not use gas or powder formulation when windy.
h. Store poison in a safe place.
i. Dispose used containers properly.

E. Weevil

The corn weevil or "*bukbuk*" is the most common storage pest that infest stored grains. These weevils measuring 2.4-4.5 millimeters long characterized by their elongated snouts cause tremendous losses to as much as 95%.

Management Recommendations

- *Sanitation.* This could be achieved in clean storage room through systematic piling of stock providing ample space for regular inspection.
- *Disinfestation.* The storage structures and containers should be disinfested or sterilized before storage of grains.
- *Chemical Control.* These are done by spraying, dusting, fogging, or fumigation with appropriate chemical.
- *Mechanical Control.* Storing of well-dried grains to prevent weevil damage. Apply mechanical control through re-drying, aeration and other means of disturbances to infested grains.
- *Environmental Control.* This is a method of modifying temperature, relative humidity and gas composition creating an atmosphere lethal or detrimental to the growth of pests. This can be done through vacuum packing, cold storage, hermetic cocoon, etc.

Harvesting is an activity before the post-harvest operations such as husking, shelling, drying, and storing.

Proper handling of harvest will minimize post-harvest losses in quantity and quality which is estimated to reach 1.3 percent during harvesting, 2.7 percent for shelling, 4.6 percent for drying, and 3.1 percent for storage *(1998 BPRE Annual Report)*.

High aflatoxin level at harvest may be caused by poor agronomic practices, insect /pest infestation, etc.

I. HARVESTING

A. When to harvest?

Proper timing of harvesting corn minimizes losses. Early harvesting may result to immature grains which affect the quality of harvest. Late harvesting will expose the crop in the field from unfavorable weather condition which can damage the crop as well as losses due to lodging and possible theft.

As reference, the following are the indices of maturity for corn:

1. Maturity date

Harvest only at the right maturity with low moisture content. Maturity dates of corn ranges from 95-120 DAP and may vary depending on variety, season and location.

2. Color

Matured corn will change its color from dark green to drying color of leaves and husk.

3. Black Layer (See Figure 19)
This is the formation of tiny black color from the lower tip of the kernel which means that the flow of nutrients to the seed had been blocked and it is already a sign of physiological maturity.

Other tips when to harvest include:
1. Prepare a harvesting plan.
2. Harvest at correct maturity & low moisture content.
3. Harvest on good weather condition.
4. Harvest only if drying can be done.
5. Harvest only the capacity of the dryer.
6. Protect harvested earcorn from contamination with soil.
7. Physical segregation of damaged earcorns.

B. How to harvest?
Harvesting of corn can be done manually by hand picking and breaking the corn ear from the stem *(See Figure 20).*

A combine harvester may also be used in harvesting huge areas of corn. This is a kind of harvesting machine where it can simultaneously perform harvesting and shelling.

II. SHELLING/THRESHING
As a general rule, shelling should be done only if drying is possible immediately after shelling.

A two stage drying is recommended to avoid excessive losses in quantity and quality. This will be done by dehusking and drying the earcorn to a moisture content level of 18-20% before shelling to prevent cracks and broken grain that can be easily attacked by molds that produce aflatoxin.

III. DRYING

Grain drying is performed to reduce moisture content to 14% and below for safe storage. Other objectives of drying include the following:

1. to increase storage life,
2. to prevent deterioration in quality, and,
3. to reduce bio-respiration

Drying can be done thru the aid of sunlight or by mechanical means. Sundrying has the advantage as it is the cheapest method. The disadvantage of this method is its unavailability especially during rainy season.

Mechanical dryer has the advantage as it is available all the time. It reduces losses in quantity from spillage and quality losses by mixing stones and other unwanted materials to the grain.

IV. STORING

Farmers and traders store their harvest for the following purposes: 1) food reservation, 2) seed reservation, and 3) waiting for a better price.

Proper management of storage facility prevents deterioration of seeds. When not taken cared of, stored seeds maybe affected by the following problems: 1) respiration, 2) germination, 3) insects, 4) fungi and other micro-organism, and 5) rodents or birds.

Storage pests can be controlled thru an integrated management practices such as:

A. Physical method which involves hygiene and physical removal, re-drying, cold storage, aeration, hermetic storage, and physical shock or any kind of disturbances.

B. Biological method which uses live insects or animals that will serve as parasites, predators and hermigores to the insect pests.

C. Chemical control introduces grain protectant, residual and surface treatment, and fumigation for a complete control of pest.

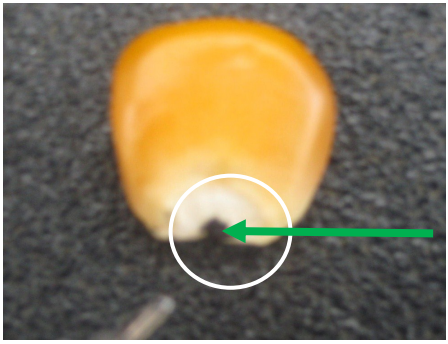


Figure 19. Picture of a black layer in corn.

Figure 20. Harvesting corn by hand-picking

Aflatoxin Contamination

Aflatoxin is produced by mold growth *Aspergillus spp. (flavus and parasiticus).* To avoid the detrimental effects of aflatoxin to human health, corn grains intended for food should not exceed aflatoxin level of 20 ppb. For livestock feeds, it should not exceed 50 parts per billion (ppb).

These toxin producing microorganisms are present everywhere. However, good agricultural practices, proper drying, handling, and storage of the grains will prevent mold development that produces aflatoxin.

Management Recommendations

A. Conventional Practice

- Corn crops exposed to stress such as drought, disease incidence, insect infestation and delayed harvesting are prone to aflatoxin contamination. Implement proper crop management from planting to harvest to prevent aflatoxin.

- Utilization of appropriate equipment to facilitate harvesting and post harvest operations.

- Avoid shelling of newly harvested corn (moisture content (MC) above 20%). Shelling above 20% mc promotes breakage and predisposes grains to microbial action. Reduce the moisture content to 18-20% before shelling so that grains can withstand mechanical stress during shelling.

- Shelled corn with high moisture content (above 20%) should be dried immediately using either mechanical or solar drying method.

B. Modern Facilities

The use of two-stage drying facilities like village-type corn processing center, NABCOR type processing center and Reina Mercedes grains processing center is also highly recommended to farmers.

Corn is marketed immediately after drying. However, farmers are encouraged to store their produce and wait for higher prices, if possible.

Marketing strategy is an operating scheme which must be devised to attain its marketing objectives and target.

Strategies for developing markets:

- Effective producers organization. It is beneficial for a farmer in a cluster area to be a member of an association or cooperative. Organizations have more voices/ bargaining power and maximize their gains in the industry through bulk handling and marketing of its members' produce.

- Increase volume of sale. Knowing the requirements of the buyers enables cooperative to program the production to meet the specific demands. This will ensure marketability of produce.

- Keep channels as short as possible. It is an efficient system that encourages fair trading with end-consumers (direct marketing to processors/millers) with the assurance of accurate weights and measures of the product.

- Adopt appropriate technologies and efficient infrastructure. Continuous innovation or planned technology must be pursued to achieve production efficiency by lowering production cost and improving the cooperative's competitiveness.

- Provide adequate financing. Sufficient capital for a producer ensures effective and smooth marketing operations.

- Maximize use of available resources. Access to available post-harvest facilities enables the cooperative

to reduce grain losses and spoilage. It preserves the produce for a longer period of time.

- Improve handling methods. An effective handling will result to a number of important improvements such as reduced harvest losses, better market positioning and higher income for the cooperative and individual members.

- Know government rules. Well-defined policies and procedures guide the actions and decisions of the cooperative management on the directions set by the general membership.

- Establish linkage between or with appropriate agencies. There are potential markets for Coop products.

Figure 21. Cagayan Valley Marketing Channel for Yellow Corn.

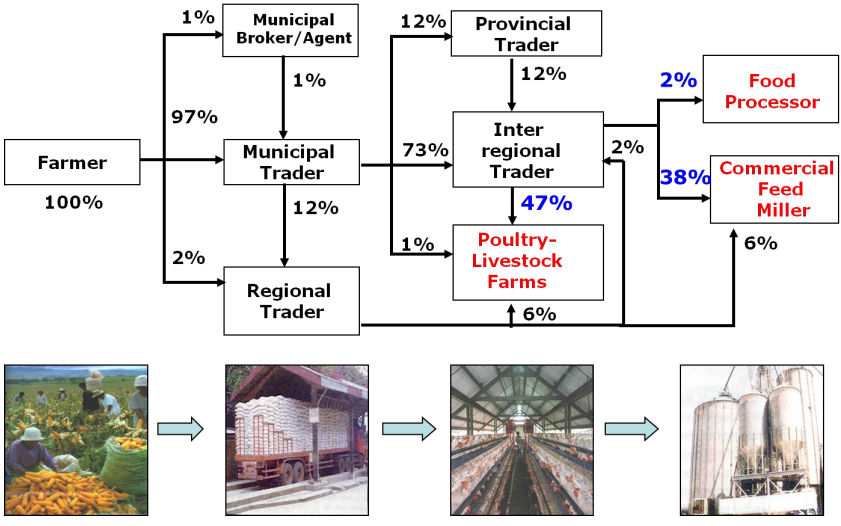


Table 8. Product Specification of Traders and Feed Millers (Yellow Corn) CY 2003

Product Specification	Traders	Feed Miller
Moisture Content (%)	14-18	8.3-14
Broken (%)	-	2-5
Allowable Dirt (%)	-	1-2
Aflatoxin	-	50 ppb

Source: *NCL Market Assessment Project, CY 2003*

Table 9. Product Specification of Food Processors (Yellow Corn) CY 2003

Product Specification	Processors
Aflatoxin	NMT 20 ppb
Moisture Content	11.0 – 13.0
Bulk Density	0.75 – 0.79 g/ml
Defective kernels -Heat damage germs -Broken kernels -Cracked Kernels -Reddish colored kernels -Insect/weevil infested -Moldy Black Colored Germ -Immature kernels	Percent by weight Max. 7.0 Max. 5.0 Max. 15.0 Max. 6.0 Max. 2.0 None Max. 1.0
Impurities/Foreign Matter -Wheat Grains -Corn Cobs/Hulls -Dust/Leaves	 Max. 0.40 Max. 0.50 Max. 1.0

Source: *NCL Market Assessment Project, CY 2003*

Table 10. Economic analysis of corn production per hectare; 2011

ITEMS	YELLOW			WHITE FLINT		GLUTINOUS		SWEET CORN
	GMO Hybrid	Conventional Hybrid	OPV	Hybrid	OPV	Grain	Green	Green
A. Labor Cost								
1. Land preparation (tractor)	1,500.00	3,000.00	3,000.00	3,000.00	3,000.00	3,000.00	3,000.00	3,000.00
2. Furrowing	900.00	900.00	600.00	900.00	600.00	600.00	600.00	600.00
3. Basal fertilizer application	720.00	720.00	360.00	720.00	360.00	360.00	360.00	360.00
4. Planting	2,160.00	2,160.00	1,440.00	2,160.00	1,440.00	1,440.00	1,440.00	1,440.00
5. Spraying of pre-emergence herbicide	-	800.00	800.00	800.00	800.00	800.00	800.00	800.00
6. 1st Spraying with glyphosate	1,200.00	-	-	-	-	-	-	-
7. Sidedressing with N-fert.	900.00	900.00	540.00	900.00	540.00	540.00	540.00	540.00
8. 2nd spraying with glyphosate	1,200.00	-	-	-	-	-		-
9. Spraying with insecticide	-	1,600.00	1,200.00	1,600.00	1,200.00	1,600.00	1,600.00	1,600.00
10. Harvesting	3,600.00	3,600.00	2,160.00	3,600.00	2,160.00	2,160.00	2,520.00	2,520.00
11. Hauling	1,350.00	1,350.00	900.00	1,200.00	800.00	750.00	800.00	800.00
12. Shelling	2,430.00	2,430.00	1,800.00	2,160.00	1,530.00	1,278.00	-	-
13. Hauling to drying pavement	1,350.00	1,350.00	1,000.00	1,200.00	850.00	710.00	-	-
14. Drying	2,400.00	2,400.00	1,800.00	2,112.00	850.00	800.00	-	-
Total	**19,710.00**	**21,210.00**	**15,600.00**	**20,352.00**	**14,130.00**	**14,038.00**	**11,660.00**	**11,660.00**

Table 10. Economic analysis of corn production per hectare; 2011

ITEMS	YELLOW			WHITE FLINT		GLUTINOUS		SWEET CORN
	GMO	Conventional	OPV	Hybrid	OPV	Grain	Green	Green
B. Material Cost								
1. Seeds	8,000.00	3,500.00	480.00	3,000.00	480.00	480.00	480.00	14,000.00
2. Fertilizer	12,400.00	12,400.00	7,820.00	12,400.00	7,820.00	7,820.00	7,820.00	12,400.00
3. Herbicide	2,000.00	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00
4. Insecticide	-	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00	2,000.00
5. Sacks	1,215.00	1,215.00	900.00	1,080.00	765.00	639.00	-	-
6. Twines	50.00	50.00	50.00	50.00	50.00	50.00	-	-
Total	**23,665**	**19,165.00**	**11,250.00**	**18,530.00**	**11,115.00**	**10,989.00**	**10,300.00**	**29,400.00**
C. Economic Analysis								
Yield (kg/ha)	8,000.00	8,000.00	6,000.00	7,000.00	5,000.00	4,000.00	40,000.0	35,000.0
Price per:								
Kilograms	11.50	11.50	11.50	11.50	11.50	18.00	-	-
Piece (ear)	-	-	-	-	-	-	2.00	4.00
Gross Income	92,000.00	92,000.00	69,000.00	80,500.00	57,500.00	72,000.00	80,000.00	140,000.00
Cost of Production	47,375.00	40,375.00	26,850.00	38,882.00	25,245.00	25,027.00	21,960.00	41,060.00
Net Income	44,625.00	51,625.00	42,150.00	41,618.00	32,255.00	46,973.00	58,040.00	98,940.00
R.O.I.(%)	94.2	127.9	157.0	107.0	127.8	187.7	264.3	241.0

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http://www.google.com.ph/

Acuminate	-	Tapering to s prolonged point.
Achene	-	Small dry indehiscent one seeded fruit developed from a simple ovary.
Annual crop	-	Plant living for one year of growing season
Basal Application	-	Applying fertilizer before planting.
Broadleaf weeds	-	Dicotyledonous plants with netted-veined leaves.
Coleorhiza	-	Root sheath in the embryo of grasses.
Chlorotic	-	Abnormal Yellowing of the plant.
Clod	-	A mass of soil produced by plowing or digging which usually slakes easily with repeated wetting and drying.
Corymb	-	A raceme in which the flowers from a flat or slightly convexed head.
Culms	-	Hollow stem of grasses and sedges.
Decumbent	-	Lying or trailing on the ground.
Digitate	-	Divided into parts resembling fingers.
Disease	-	Any deviation from normal due to bacteria , fungi or virus , toxicity or nutrient imbalance.
Elliptical	-	A cone-like circular shape of stems.
Fine –textured soil	-	Roughly clayey soil containing 35 percent of more of clay loam, silty clay and clay.
Fungus (pl. fungi)	-	A group of thallophytes which is characterized by the absence of chlorophyll and subsists in dead or living organic matter. They exhibit spongy morbid growth.
Furrow	-	A narrow trench formed when plowing.
Germination	-	Refers to seed emergence or the development of a seed into a plant.
Glabrous	-	Smooth, devoid of pubescence or hair of whatever form.

Hill	-	A plant or a cluster of plants.
Hilling-up	-	Turning the soil towards the base of the plants by cultivating with a plow.
Instar	-	Period of growth between two moltings.
Lanceolate	-	The shape of leaf with narrow margins tapering towards the apex.
Leaching	-	Downward movement of nutrient element in solution beyond the reach of roots.
Leaf sheath	-	The leaf base where it forms a vertical coating surrounding the stem
Lesion	-	A well-marked but limited diseased area
Ligule	-	A thin membranous projection from the tip of the leaf sheath in grasses.
Loam	-	The textural class name of soil having a moderate amount of sand, silt and clay. Loam soil contains 7-27% clay, 28-50% silt and less than 52 % sand.
Mottling	-	Spotting or blotching of the leaves.
Monocotyledons	-	Plants with only one seed leaf or cotyledon
Moisture content	-	The amount of moisture present in seeds or grains, usually expressed in percent.
Nymph	-	Young of insect which has not completely changed to an adult stage.
Ovate	-	Shape of leaves characterized by a broader end at the base.
Off-barring	-	Turning the soil away from the base of the plant when cultivating the plow.
Panicle	-	A compound inflorescence of the racemose type, forming a lose and irregular

Pappus	-	Downy or feathery appendage on the achenes or “seeds”.
Peduncle	-	Flower stalk supporting either a cluster or a solitary flower.
Petiole	-	Footstalk of a leaf, by which it is attached to the stem.
Perennial	-	Plant having a life cycle or more than two years.
pH	-	Value expressing the degree of acidity or alkalinity of the soil
Pubescent	-	Covered with fine hair
Raceme	-	A simple inflorescence in which flowers are arranged in short, nearly equal, pedicels at equal distances on an elongated axis.
Rhizome	-	Root-like subterranean stem, commonly horizontal in position, arising below and sending up shoots to the upper surface of the soil. This is common in sedges.
Rogue	-	To uproot or destroy diseased and off-type plants.
Sessile	-	Having no footstalk, immediately attached by the base.
Side –dressing	-	Placing fertilizer to, between, or around the plants.
Silk	-	The hair-like styles on corn ears.
Tassel	-	The male flower of corn.
Thinning	-	Reducing the number of plants in a hill to attain optimum growth and yield.
Virus	-	Infection agent, smaller than the common microorganism and requiring living cells for multiplication.
Whorl	-	Young leaves or shoots of corn plants

APPENDICES

Appendix 1. Management Guide for the Growth Stages of Corn

The critical stages of growth of the corn plant can be easily identified. Likewise, the time from emergence to any of the stages can be predicted in normally growing plants, using the number of expanded leaves before flowering, appearance of the reproductive organs and kernel development. These stages are as follows:

1. *Emergence*– After sowing, and under favorable conditions, the seeds swell and the embryo enlarges. The coleorhizae closing the radical emerges first. The radical elongates rapidly followed by the plumule. Two to five seminal roots emerge at the base of the plumule. These roots and radical constitute the primary root of the young seedlings. The first internode formed elongates to raise the plumule is exposed to light, it burst and two leaves emerges. Adventitious roots develop at the node just below the surface of the ground. These become the permanent root system of the plant. Regardless of the depth of planting, the permanent roots develop only new centimeters below the ground surface. The first internode between the seminal roots and the permanent roots (mesocotyl) normally elongate to more than 5 inches.

   Management Guide. Guide of planting influences the length of time of planting to emergence. Seedling s from deep-planted seeds have a greater depth of soil to penetrate. In addition, the temperature is cooler at greater depths and growth is slower. Nutrients and food reserve in the seed generally supply the young plant adequately prior to emergence . Place the fertilizer too near the seed can result in salt injury to the young plant.

2. *Two leaf stage.* The emergence of two leaves marks the beginning of a new mode of growth of the plant . The roots at the base of the first two leaves elongate but have not yet branched or formed root hairs.

Management Guide. Since the root are relatively small, higher concentration of fertilizer is needed to stimulate early plant growth. However, the amount of nutrients required is relatively small. The fertilizer is effectively absorbed at this stage if placed in band where the primary roots get in contact with it. Roost are not attracted to this fertilizer band, so that the fertilizer must be placed where the roots grow. It takes about a week from the plant emergence to this stage.

3. *Fourth leaf stage.* At this stage, roots of the first node branch and develop root hairs. The primary roots grow very little, and usually die but new the stem, but it still below the soil surface. All leaves and ear shoots have initiated.

   Management Guide. Cultivating too near the plant after the stage destroys some of the permanent roots. Exposed leaves maybe damaged but the plants may outgrow damage parts with little reduction in yield.

4. *Sixth leaf stage.* The permanent roots of the first and second nodes are extensive and well-balance while new roots are elongating at the third node. The internodes of the fifth, sixth and ear shoots have been initiated and the growing point levels with the ground surface.

   Management Guide. Since the nodal root system is now well-distributed in the soil, precise placement of fertilizer is less critical. However, the plant node begins to absorb greater amount of nutrient . Fertilizers should be applied in adequate amount to supply deficient nutrients in the soil. Root worm may destroy the developing nodal roots and thereby restrict plant growth . Later , root development at higher nodes may result in plant recovery

5. *Eight leaf stage.* The leaves and stem grow rapidly at this stage. The growing tip is already 2-3 inches above the ground. The permanent roots are extensive and well-branched. The tassel starts to develop rapidly.

Management Guide. Nutrient deficiencies at this stage will seriously restrict leaf growth. Nitrogen fertilizer may be effectively side-dressed up to this stage if the fertilizer is placed in moist soil and if serious injury to the root system through root pruning is avoided.

Corn borer eggs begin to hatch at this stage. Watch for leaf feeding insects and threat if necessary.

Flooding at this stage or during previous stages when the growing point is below the soil surface can kill corn plants in a few days, especially at high temperatures. Flooding at later stages, when the growing point is above the water, is not as detrimental.

6. Tenth leaf stage. The tenth to the last leaves are fully formed but not fully opened. Tassel develops rapidly at this stage. While the ear shoot develops at the sixth to eight nodes above the ground. Nutrient uptake especially nitrogen, phosphorus and potassium is rapid.

Management Guide. Moisture and nutrient deficiencies at this stage significantly influence the growth and development of the ears. Since the root system is extensive, band application of fertilizer is not essential. Plowed under fertilizer is preferred since surface-applied nutrients in the dry soil may be unavailable to the plants.

The stalk is now growing well above the soil surface. Plants that are broken below the growing point will not recover. Yield losses from leaf damage are greater than at any previous stages.

7. Twelfth –sixteenth leaf stages. Enhancement of the leaves is completed. Tassel and stalks grow rapidly. Ears, especially the upper ones, are developing rapidly. The number of ovules which becomes kernels when fertilized is determined at the this stage.

Management Guide. This is the critical period in determining the size of the uppermost ears. Moisture deficiencies at this time may seriously reduce the potential size of the ear to be harvested. Early maturing varieties, which progress through these stages in a shorter time than late maturing varieties, usually have small ears and plant size and must have more plants per unit area to produce the same grain yields.

8. *Last leaf stage.* The tip of the tassel has emerged. The upper internodes elongate rapidly. Ears are enlarging fast and silks are growing rapidly.

   Management Guide. The number of ovules which developed silk and the number of kernels is determined. Moisture stress or nutrient deficiencies usually increase in intensity from the top to the bottom of the plant and delays silking more than tassel emergence and pollen shedding, resulting in low seed sets.

   Complete leaf removal at this stage results in 25-30% yield loss.

9. Silking and pollen shedding. The leaves and tassel have fully emerged and stem elongation ceased. Cobs and silk continue to elongate until they are fertilized. Ovules are enlarging. Tassels continue to shed for about a week.

   Management Guide. The number of fertilized ovules is determined at this stage. Moisture stress or nutrient deficiency may result in poor pollination and seed setting. Earlier planting and other management practices should be followed for this stage to coinside with favorable climatic conditions.

   Watch for corn silk beetles on silk. Treat if necessary.

10. *Blister stage [12 days after silking (DAS)].* The cobs, husk and shanks are fully developed. The kernels are accumulat-

kernel development. The embryo in each kernel develops.

Management Guide. This is the beginning of rapid increase in grain weight. If possible, irrigate the field to assure adequate moisture for grain production. Loss of leaves from unfavorable conditions at this time results in many unfilled kernels usually at the tip of the ear.

11. *Dough stage (24 days after silking).* The kernels are developing rapidly. Hard starch begins to accumulate in the endosperm.

Management Guide. This is the beginning This is the beginning of the rapid increase in grain weight and development of young plants in the embryo of each seed. Unfavorable conditions or deficiencies in nutrients such as potassium result in unfilled shrunken kernels.

12. *Hard dough stage (30DAS).* Growth of embryo is rapid . Endosperm is fully enlarged.

Management Guide. Grains continue to rapidly increase dry weight. Likewise, the growth of the young plant in the embryo of each seed still continues. Unfavorable conditions or potassium deficiency results in unfilled or chaffy ears.

13. *Maturity stage* (40-45 DAS). The husk and some of the leaves are no longer green. Dry matter accumulation has ceased. The kernels and their embryo are fully developed. Grains start to loss moisture content (30-40%). Delaying harvest time for about a week results in the drying of grains to about 20-25% MC.

Appendix 2. Biological Control of Corn borer using trichogramma.

BIOLOGICAL CONTROL:

1. *Trichogramma spp.*

	DAYS AFTER PLANTING (DAP)/ NO. OF CARDS	
RELEASE AREAS	**28-30 DAP(1st Release)**	**35-37 DAP (2nd Release)**
New	50-70 cards	50-70 cards
Old*	30-50 cards	30-50 cards

*Areas previously released with Trichogramma

2. Earwig, *Euborella annullata*

NO. OF RELEASES	STAGE OF CROP	DISTANCE BETWEEN RELEASING POINTS*	NO. OF COLONY**/ RELEASE
1ST Release	Mid-whorl	10 x 10 meters	2 Colonies
2nd Release	Tasseling-Silking	10 k 10 meters	2 Colonies

*1 Tbsp/releasing points

**1 Colony = ≥ 5,000 earwigs

Appendix 3. Collection of Composite Soil Sample for Laboratory Analysis.

Accuracy of soil test results depends largely on the proper collection of the soil sample to be analyzed. The sample collected should represent well the whole area planted, to come up with a very reliable fertilizer recommendation.

Steps in collecting composite soil sample are:

1. Divide the field into sampling area. A sampling area represents one soil type, one topographic condition and one cultural method and may cover as much as ten hectares.

2. For each sampling area, collect seven to ten spot samples evenly distributed over the area. The spot samples collected represent a composite sample for analysis of the whole area.

3. To take a spot soil sample, first clear soil surface from stones, litters and vegetation. Using a spade, dig a pit to a depth of 20-30 cm. From one side of the pit take a slice of soil 2-3 cm thick with a single thrust of the spade. Using a knife, trim the slice of soil on both sides to a bar of one inch width. Place the bars of soil collected from the different spots into a pail or any available clean container.

4. Break up the large lumps of soil and mix thoroughly. Place on a clean plastic or paper and air dry. Keep away from foreign materials that can cause contamination.

5. When dried put in a clean plastic bag with the following information written on a clean paper or cardboard:

Label/Field No.:_____ Lot No.: _____
Name of Farmer:
_____
Address:
_____
Farm Location:
_____
Sitio: _____ Barangay: _____
Town:_____ Province: _____
Area of farm (Ha): _____
Previous crops planted: _____
Crop and variety to be fertilized:_____

6. Submit for analysis to either the:

Regional Soils Laboratory
Department of Agriculture, RFO 02
Nursery Compound, San Gabriel,
Tuguegarao City, Cagayan

or

Ilagan Soils Laboratory
DA-CVIARC
San Felipe, Ilagan, Isabela

7. Soil analysis should be made every 2-3 years or whenever the need for it arises.

Appendix 4. Bio-N : Nitrogen Supplement for Corn

Bio-N is a seed inoculant containing Azospirillum, a nitrogen-fixing bacteria isolated from the roots of Talahib (Saccharum spontaneum L.). The bacteria is capable of converting atmospheric nitrogen into a form which can be directly used by plants. Bio-N is applied to the seeds prior to planting for better seed emergence and vigor.

Benefits Derived from Using Bio-N:

1. Bio-N contains a growth hormone that enhances longer and denser root development.
2. Augments total nitrogen requirement of corn plants to as much as 30%.
3. Increases yield.
4. Makes plants more resistant to pests and drought.
5. Environmentally safe.

How to Apply Bio-N: (should be done in a shady location)

1. Place 3 kg seeds in a basin or any suitable container for easy mixing;
2. Moisten the seeds with just enough clean water;
3. Add one pack bio-N to the moistened seeds. Mix thoroughly until the seeds are well coated. One pack (200 g) of Bio-N can inoculate 3 kg of corn seeds.
4. Air-dry inoculated seeds and plant immediately.

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