CITRUS PRODUCTION AND MANAGEMENT

A Technology Guide

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MESSAGE

Benguet State University continues to pursue its commitment of providing extension services that are research results aligned with quality education and sustainable development practices. This year's University Foundation theme, "Creating Milestones toward Global Engagements: BSU @102," this knowledge product (KP) timely and relevant. It concretizes important steps to bring to fruition our vision of delivering quality education and client satisfaction that promotes sustainable development.

Through this technology guide, BSU has upscaled research-based initiatives and technologies thru handy materials for use by varied audiences - from farmers, homemakers, fieldworkers, and extensionists. By circulating this knowledge product, the development of a critical mass of farmers who adopt and champion BSU technologies will be facilitated effectively and support sustainable development and continuing innovations from the field. It is our fervent hope that in the long run, this knowledge will contribute in improving quality of life and increasing income of our communities and clients.

I congratulate the Office of Extension Services' team for producing this knowledge product which is a testimony of BSU's prolific knowledge generation and continuing commitment to serve its communities. This should encourage other knowledge holders to work on translating their knowledge into tangible KPs.

Mabuhay tayong lahat!

FELICIANO G. CALORA JR.
University President
Benguet State University
27 September 2018

MESSAGE

The Research and Extension (R&E) sector's goal explicitly states, "developing relevant and gender sensitive research and extension programs for institutional development, sustainable communities, climate resilience, industry innovation, and partnerships." To do this, there is a need to share research results in different platforms for BSU- R&E outputs to reach the widest audience possible. The production of knowledge products by the Office of the Extension Services is a step towards addressing the different needs of our client in this increasingly competitive and changing world. With many years of extension work, there is also an increasing recognition to capacitate Extension Service Providers aside from directly working with clients, and one way is to use knowledge products (KPs) tailored to answer this emerging need of the sector. Many of the knowledge products developed therefore are for these extension service providers. Specifically, this technology guide on citrus production which puts together research work outputs as well as actual experiences, aims to facilitate the work of the university research and extension.

It is hoped that this KP will be utilized and will serve its purpose which is a handy guide for extension workers, and also the bigger public such as citrus growers and interested farmers in the region and in the neighboring provinces with similar environmental condition. The technology guide is a concrete manifestation of technologies generated in the academe and translated into a language that can be used by the popular sector.

I congratulate the Extension sector for coming up with various knowledge products which is a timely response to the very fast changing and challenging prospects of the times. Being the lead University in the region, it is but proper that we also lead in this kind of engagements, while working for excellence and innovation for client satisfaction.

CARLITO P. LAUREAN
Vice President for Research and Extension
Benguet State University
27 September 2018

MESSAGE

In the journey of extension work, we gain knowledge through our exposure to different fieldwork experiences and interaction with our development partners. In the process, we generate knowledge and build on it, making each one of us "knowledge holders" which is magnified in the collective knowledge of our University. One way of retaining and ensuring intergenerational transfer of knowledge is through knowledge products. Knowledge Products or KPs, in the context of knowledge management, aim at transferring knowledges to identified users. What makes a KP unique is that it is a "call to action" by its intended users, enabling application of the knowledge easy and handy. This is the purpose of the technology guide developed by the Institute of Highland Farming Systems and Agroforestry.

What comes with this exercise is the "communication and pursuasion" package, a task taken by the Office of Extension Services (OES). In the process of doing these tasks, admittedly, the OES had several realizations: the urgency of tapping knowledge holders (who are retiring), the need to maximize resources which required a multidisciplinary lens and in the process, the need to refine some "extension processes" necessary for extension operation to adopt to the "changing times." These are difficult tasks but in this way, we have innovated the generation of knowledge for our intended specific audiences.

In this age where knowledge-based economy is increasingly becoming important, we believe that knowledge generation, transmission and application is facilitated through the culture of sharing. Through this techno-guide, we hope to contribute to the circulation of technology and innovation menu while innovating further on knowledge and technologies.

RUTH S. BATANI
Director
Office of Extension Services
Benguet State University
27 September 2018

MESSAGE

Citrus is an essential dietary need for healthful nourishment. Regrettably, much of the product is imported and prices are often too expensive for most Filipino consumers. Although research and extension activities are continuously pursued for this commodity, local production cannot sustain demands.

The Benguet State University, through its goal of promoting agricultural productivity in the Cordillera region, established institutes and centers to cater to research, training and extension programs of different crop commodities. The Institute of Highland Farming Systems and Agroforestry (IHFSA) is one institute tasked to promote agroforestry farming systems. In the implementation of its programs, citrus cultivation has been part of its agroforestry development projects. It is acknowledged that there were people who devoted and earned relevant experiences through their services to the Institute specifically in citrus production and management.

I commend Nelson O. Buayan and Adolfo N. Bilag, with the assistance of our research staff Von Y. Amado and Loida L. Malucay for unselfishly sharing their hands-on experience in citrus production to be consolidated and published into this technology guide making it accessible to interested clients. I hope that this techno-guide will be of great help to those who wish to engage in citrus farming in the context of highland conditions.

ANDRES A. BASALONG
Director
Institute of Highland Farming Systems and Agroforestry
Benguet State University
27 September 2018

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PREFACE

This technology guide presents the basic principles of citrus production. Although the basic principles of fruit production are universally applied, this guide features the propagation and production practices mostly appropriate to highland conditions. Proper harvesting and handling practices are also included. This guide is developed with results of various researches at Benguet State University over a long period of time. It integrates the indispensable knowledge and experiences of the subject matter experts. It is with hope that this guide will also serve as an eye opener to the potentials of the citrus industry in the Cordillera region.

Similarly, it may also serve to jumpstart research development and extension (RDE) activities to illuminate areas that this guide may have missed to address.

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Introduction

Citrus (*Citrus spp.*) has a wide range of adaptability. The fruit is rich in vitamins and minerals and has medicinal properties. If processed, it yields into various by-products. Citrus fruits grown in the country include different types of oranges, calamondin, mandarin, pomelo, lemon, and lime. Citrus has a great potential as a commercial crop in the Cordillera Administrative Region (CAR) because of the semi-temperate condition in many of its areas. In a study done by Ochasan et. al. (2012), they identified other regions in the country where citrus are commercially grown which include Region I (Ilocos), Region II (Cagayan Valley), Region III (Central Luzon), Region IV-A (CALABARZON), Region IV-B (MIMAROPA), Region V (Bicol), Region VI (Western Visayas), Region IX (Zamboanga Peninsula), Region X (Northern Mindanao), Region XI (Davao), and Region XII (SOCCSKARGEN). The FAO (2016) reports indicate a steady decline of Philippine citrus production from 65,600 metric tons in 2008 to 48,800 metric tons in 2015. Thus, the production level still cannot meet local demands. Imported citrus augments this deficit with about 83,700 metric tons imported in 2015; the highest volume imported was 115,600 metric tons in 2012.

The Citrus industry in the Philippines was once a major fruit industry in the 1950s until the 1970s when it declined because of the spread of virus and virus-like diseases particularly Huanglongbing (HLB), also called leaf mottling/greening disease and severe strains of Citrus Tristeza Virus (CTV). To date, CTV, HLB and their insect vectors are reported to be found in all citrus growing areas in the country, resulting to low productivity and loss of trees (Ochasan, 2018). Apart from plant diseases, other problems that beset the citrus industry include the long period for trees to reach maturity, short life span of productive trees, and high cost of farm inputs. In addition, the lack of improved, disease-free planting materials and the need for new cultural techniques still persist.

Despite these problems, citrus is still being sought by Cordillera farmers, as evidenced by their consistent queries for planting materials at the University. Recently, the government's goal of increasing agricultural land and crop productivity helped renew interest in citrus growing. However, the major constraint to the further development of the citrus industry is the lack of quality planting materials, which are healthy or

free from injurious pests and diseases and true-to-type of the variety. Furthermore, citrus farmers have to practice the appropriate cultural management practices.

This technology guide offers a practical and simplified steps in citrus production. The basic principles of fruit crop production are also considered in this guide. However, practices may vary from one region to another depending on various factors such as culture, climate, environment, soil and economic condition. Thus, this guide only focuses on practices observed and from the first-hand experiences of the subject matter specialists.

Varieties

Although more citrus varieties are cultivated in the region, only those that are actually observed and tested at the BSU-Pomology and at the Institute of Highland Farming Systems and Agroforestry (IHFSA) are considered in this techno-guide. Some of these citrus varieties are the following:

1. Mandarin

   - Satsuma mandarin *(Citrus reticulate blanco)*
   - Ponkan mandarin *(Citrus reticulate)*

2. Grapefruit *(Citrus paradis)*

3. Summer orange *(Citrus daidai)*, also called Natsumikan in Japanese

4. Lemon *(Citrus limon)*

   - Meyer, a variety more adaptable compared to Eureka and Lisbon varieties

Cultivation Requirement

A. Climate

1. Semi-temperate: temperature range of 18-25°C
2. Rainfall: well-distributed rainfall throughout the year; areas with distinct periods (dry and wet seasons) such as Benguet has to maintain irrigation

B. Soil

1. Heavy to light sandy loam
2. Deep and fertile soils high in organic matter
3. Ideal soil pH range of 5.5 to 6.5 or moderately acidic
4. Well-drained (low water retention) to avoid waterlog or stagnation that will cause rotting of the roots
5. If the site is prone to flooding, construct drainage canals

C. Others

1. Taller trees, preferably nitrogen-fixing trees, planted around the borders to serve as windbreaks and source of nutrients through their decomposed litterfalls

Propagation of Planting Materials

A. Compatibility

Identify the most compatible combination of the scion and rootstock to ensure good plant growth and quality fruits. Below are some of the observed best scion-rootstocks combinations.

Table 1. Best scion rootstock combination

Scion	Rootstock
Mandarin	Trifoliate orange
	Calamandarin
	Rough lemon
	Rangpur lime
Ponkan	Trifoliate
Grapefruit	Trifoliate
Lemon	Calamandarin
	Citrange
	Citromelo
	Rangpur lime

B. Rootstock production

1. Seed selection

- Gather seeds from quality fruits (free from disease and insect damage).
- Carefully extract seeds from fruit to avoid damage.
- Ferment seeds to remove mucilage by soaking in clean water for 24 hours or until the mucilage or slippery substance is removed.
- Discard seeds that float during washing.
- Seeds can be stored for two weeks in cold temperature to break the dormancy of seeds and to hasten germination period to 20 days.
- Hot stratification method may also be applied; dip the seeds in hot water (70^{O}C).

2. Seedbed preparation

- Prepare seedbeds, ideally 1 m width and 10 m length or at desired length.
- Raise seedsbeds to at least 30 cm, then level the surface.
- Add sandy soils with organic matter or compost to increase water retention.
- Mix heavy soil (clayey) with the appropriate amount of sand and organic matter to make it porous and favorable for root development.
- Make small, straight furrows about 2 cm deep and 10 cm apart (see Figure 1).

Figure 1. A seedbed with furrows

3. Seed sowing

- Scatter seeds 1 cm apart along the furrows.
- Cover seeds with soil, about 2 cm thick.
- Cover the seedbed with mulch to minimize moisture loss and to control weeds.
- Irrigate seedbed at least three to four times a week using watering cans with sprinkler or garden hose mounted with fine sprinkler. The sprinkler will prevent the excessive force of the water to expose the seeds.
- Maintain seedbed moisture to at least 60%. Seeds germinate about 28-35 days after sowing.

Figure 2. Proper sowing of seeds on a seedbed

4. Care and maintenance of germinated seedlings

- Carefully remove weeds to avoid uprooting the seedlings; do this as often as necessary.
- Apply supplemental fertilizer to enhance growth of the seedlings.

5. Preparing the potting media

- Mix garden soil with compost. Decomposed rice hull may also be added to the potting media. This will minimize the hardening of soil when water is lacking.
- Recommended ratio of potting media: 30% compost, 30% rice hull, 30% garden soil, and 10% lime.
- Use black polyethylene bags with sizes of 8”x11” or 8”x12”.
- Punch holes at the bottom and lower sides of the pots for drainage.
- Fill the pots with the soil mixture until the brim (see Figure 3).

Figure 3. Black polyethylene bags filled with soil

6. Pricking and potting

- Prick the rootstock seedlings when the stem diameter reaches 3 mm (about the size of ball pen ink holder).
- Using a dibble, make a hole vertically in the middle of the filled pot.
- Insert carefully the rootstock seedlings into the pot then firmly press the sides of the pot (see Figure 4).
- Spread roots of seedlings that coiled.
- Prune root to induce growth of root hairs.

Figure 4. Proper potting of rootstock seedlings

C. Pre-budding

1. Prior to budding, sufficiently irrigate the seedlings at two to three days interval for two weeks. This will prevent the bark from adhering to the wood and enhances active vegetative growth of the seedlings.

2. Prune and maintain the seedlings to a single stem.

3. The rootstock seedling is ready for budding when the stem diameter is about the size of a pencil.

4. Rootstock should be active. Active rootstock has new shoots and the bark is easy to remove.

D. Scion stick (bud wood) preparation

1. Choose scion stick from healthy mother trees that were dormant for the last three to four months.

   • Dormant trees have dark green leaves, without new shoots, and are developing fruits.

- Scion stick could be stored if the rootstock seedlings are not ready for budding. Wrap scion sticks with moistened newspaper, place inside cellophane bag and keep in cool storage room. This could also be stored for three months in a refrigerator maintaining a temperature of 6°C to 9°C. Never allow the scion sticks to dry.

E. Scion bud preparation

1. Cut the scion buds one to two hours before the actual budding.

2. Identify the budding technique ahead of time because this also determines the type of cut to prepare.

F. Budding techniques

1. T-budding is recommended during the dry season when heavy rains is not expected (see Figure 5). The "T" cut on the stock is done about 20-25 cm above the surface with a 2 cm long vertical cut and 1 cm long horizontal cut on the stock. A slight twist with the budding knife may open the two flaps of the bark.

   Insert the bud under the two flaps of the bark by pushing downward. Ensure the flaps are closed tightly. Finally, the incision should be closed with budding tape, which should be wrapped tightly around the stem. Remove the tape after three to four weeks, if it did not already fall off.

2. Inverted T-budding minimizes the accumulation of water at the cut portion of the rootstock thus appropriate during rainy season (see Figure 6). The inverted T-budding technique is exactly the same as the normal T-budding method except that the horizontal cut is made on the bottom end of the incision. In this case, the bud is cut from the bud stick by starting above the bud and exiting below it.

   The use of inverted T-budding technique is more effective due to the downward flow of hormones that are intercepted below the bud. Compared to the normal T-budding method, the union will be stronger and the healing process will be faster.

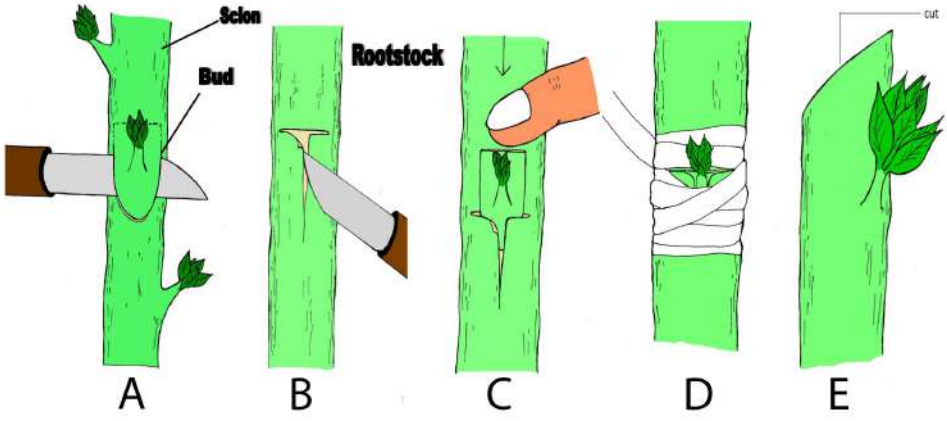

Figure 5. T-budding techniques: A) scion cut for T-budding; B) cut made on rootstock stem; C) insertion of bud; D) wrapping the bud with tape; and E) the healed union after removal of budding tape

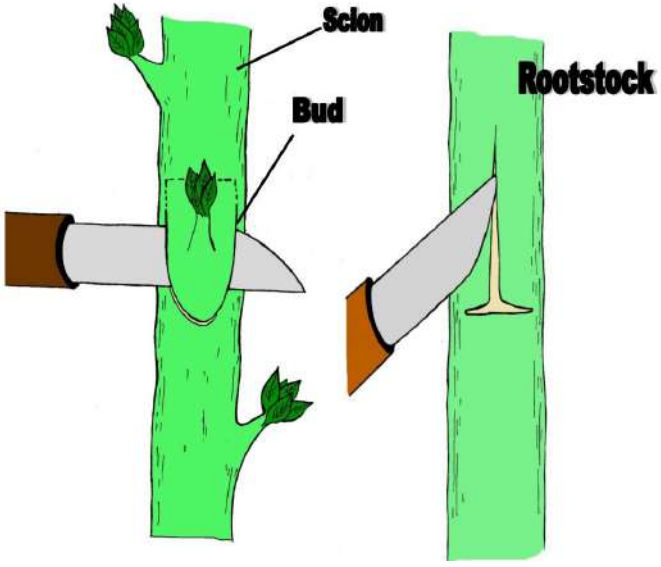

Figure 6. The inverted T-budding technique

G. Nursery management

1. Take care of the budded seedlings for about 4-6 months in the nursery.

2. Provide newly budded seedlings with protection against excessive heat and rapid loss of water (see Figure 7).

3. Manage the number of branches allowing only 1 branch.

4. Remove branches or sprouts in the union.

5. Plant the budded scion when the height is about 6 inches to 1 foot.

Figure 7. Budded seedlings covered with cellophane tubes to protect them against too much heat and to conserve moisture

Field Planting

A. Site selection and characteristics

1. Fully exposed to sunlight at least 8 hours a day

2. With good drainage, deep porous soil and high organic matter

3. Near or with sufficient water supply

4. Accessible

B. Land preparation

1. Field clearing

   - Remove shade trees, shrubs and tall grasses.

2. Lay-out.

   - Follow 2.5 m x 2.5 m or 3 m x 3 m planting distance. For rolling terrain, use triangular pattern or system to avoid shading or shadowing; for flat terrain, use square or rectangular pattern and quincunx for flat terrain (see Figures 8-10).

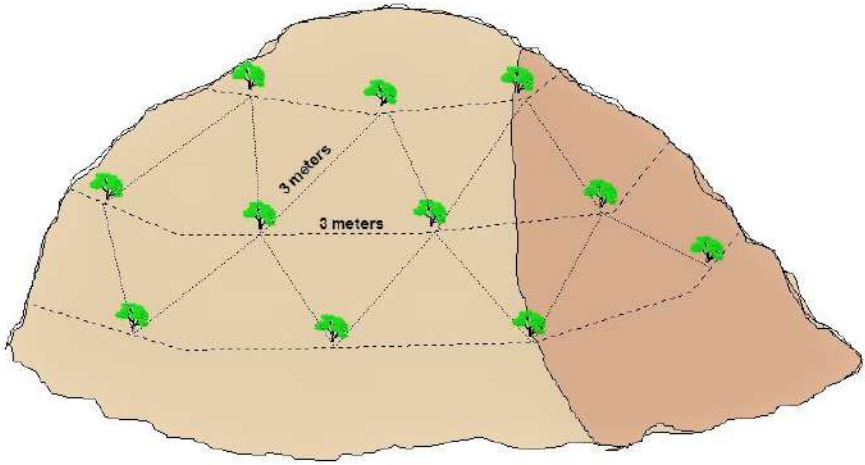

Figure 8. Contour system field lay-out for hilly or sloping areas

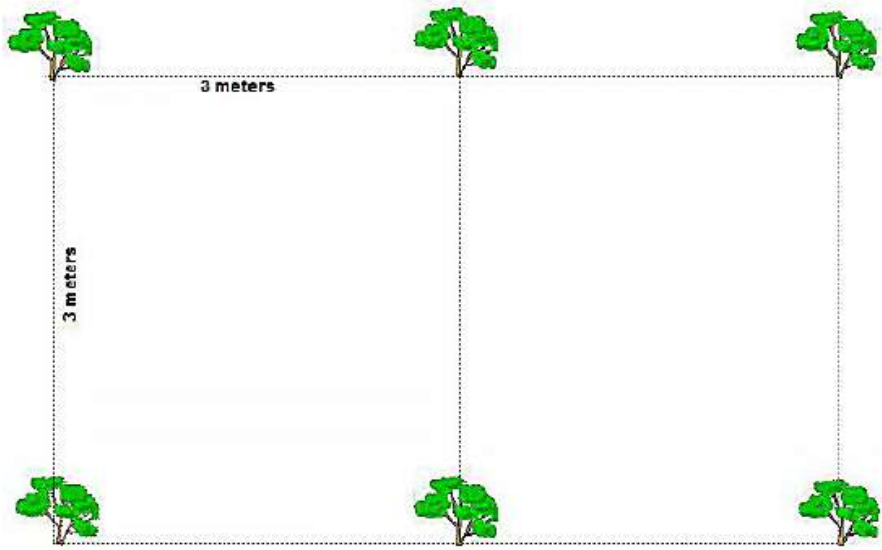

Figure 9. Square pattern or system field lay-out

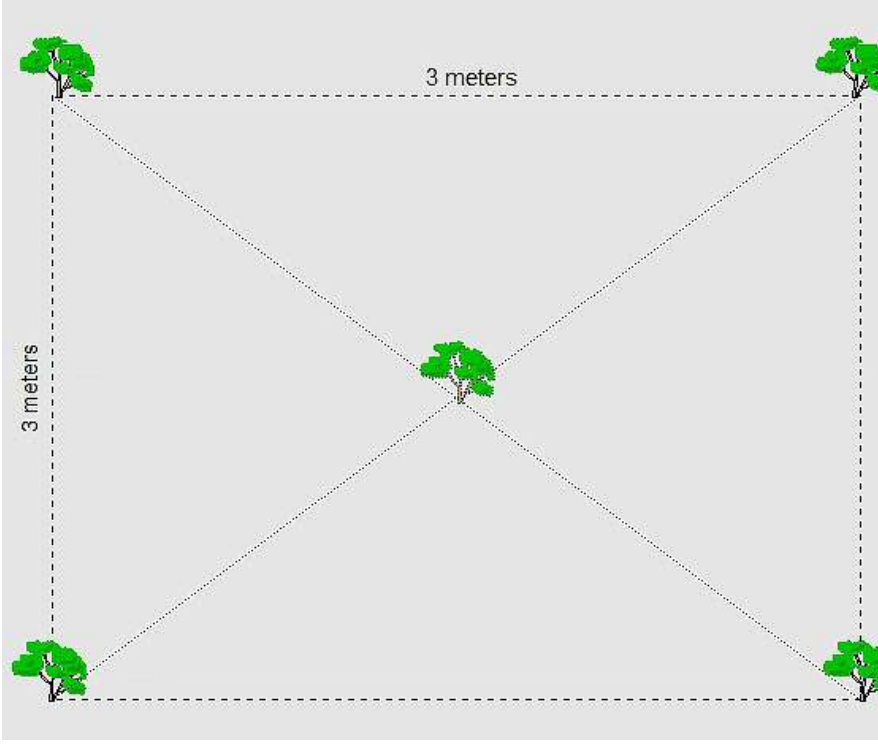

Figure 10. Quincunx system field lay-out

3. Staking

- Use sticks or bamboos as markers to indicate where the hole will be dug.

4. Hole digging

- Dig at 1 m wide and 1 m deep.

5. Basal fertilizer application

- Apply organic fertilizers such as processed chicken manure or compost. Put two to three shovelfuls per hole. Mix thoroughly with the soil. Lime may also be incorporated.

6. Covering the hole

- Return all the soil forming a mound. This will prevent foot rot due to waterlogging (see Figure 11).

7. Leave organic fertilizers to decompose

- Allow organic fertilizers to fully decompose for at least seven days before transplanting the budded seedlings.

C. Transplanting

1. Transplant during the start of the rainy season.

2. Carefully remove the pots to avoid damaging the roots of the seedlings.

3. Carefully spread the roots in the hole to enhance the growth of new and healthy roots.

4. Cover the root system with soil up to the root collar only to avoid causing foot rot disease.

5. Mound the soil at the base of the plant. This will prevent water to stagnant at the base of the plant.

6. Remove old leaves to allow better transpiration-leaf trimming –from seedling during transplanting.

Figure 11. Site ready for field planting;
(inset) the holes with sticks and formed into mounds

D. Care and maintenance

1. Irrigation

- Ensure sufficient moisture in the soil maintaining at least 40-60% level especially during the first three years in the field.
- Irrigate through sprinkling or drip method.

2. Fertilizer application

- Apply fertilizer at canopy dripline following the ring method (see Figure 12).
- Alternately use commercial and organic fertilizers.
- Fertilizer depends on the canopy size of the tree. Apply using ring method. For the first year, apply fertilizer twice. Fertilize during the start of the rainy season.
- Fertilizer application should be two to three times a year (see Annex 1).

Figure 12. Ring method of fertilizer application

3. Pruning

- Remove excessive branches during early stage of growth leaving only three to four branches. This promotes strong main fruiting branches.

4. Training of branches

- During the early stage of growth, re-orient the branches to a desired direction by tying them to wood or bamboo poles pegged on the ground.
- This enhances the development of the canopy into a desirable form and shape. This will also avoid interlapping of branches.

5. Mulching

- Cover the soil around the base of the plant with any appropriate and available material.

- Use plastic mulch or weeds removed around the citrus.
- Mulching helps conserve water, suppress the growth of weeds, regulate soil temperature during the dry season, and minimize soil erosion.
- Remove mulch during rainy season to avoid accumulation of excessive moisture that will lead to foot rot.

6. Weeds management

- Remove weeds to prevent competition for soil nutrients, water and sunlight. Do this as often as necessary.
- Weeds can be controlled mechanically (use of sickle, grass cutter), chemically (herbicide), or culturally (cover cropping, application of mulch).

7. Fruit/flower thinning

- Remove the first fruits during the first year to encourage root growth and development of sturdy branches.
- Avoid overbearing of citrus trees by fruit thinning observing the ratio of three leaves to one fruit. Yellowing of leaves is one indicator of overbearing.

Insect Pests and Diseases and their Management

Management of insect pest and diseases is important in citrus production. If neglected, damages will cause loss on the yield or permanent loss of the trees. Refer to Annex 2 for the common insect pests and diseases of citrus in the Cordillera region. It includes the damages caused by the pests, the season of occurrence and their recommended management.

Harvesting

Harvested fruits during summer with high temperature produce more and juicier fruits as compared to those harvested during rainy season. Peak season for harvesting citrus in the region is from November to April.

- Harvest fruits when the dews have dried up preferably from 8 a.m to 3 p.m.
- Indicator of maturity for orange: the fruit is ¾ yellow and the yellowing starts at the bottom.
- Indicator of maturity for lemon: the fruit is light green and a little bit soft.
- Use appropriate pruning shear when harvesting.
- Cut at the branch. Do not remove the pedicel to avoid rotting.

Figure 13. A twelve-year old Satsuma mandarin trees laden with fruits

Postharvest

A. Sorting and grading

1. Separate and discard properly the damaged or injured fruits, insect infested, and disease infected from healthy fruits.

2. Grade fruits according to size and weight.

3. Place sorted and graded fruits in separate plastic crates or appropriate containers.

B. Storage

1. Store fruits in cool, shaded, ventilated and clean storage rooms.

2. Storage rooms should be free from rodents and insects.

3. Properly stored fruits can last for three weeks up to one month.

4. Borax wax can prolong fruits' shelf life. This will preserve the skin of the fruits but will not affect the taste.

Production Cost for Citrus

An updated estimated production cost (Tipayno, 2006) as basis for establishing a citrus orchard is presented in Table 2. Studies reveal that citrus orchard farming is profitable. In Kasibu, Nueva Vizcaya, production of Satsuma, orange and pomelo nets a profit margin of 42.44%, 37.72% and 12.86% (Antonio et. al., 2011).

Table No. 2. Estimated cost of production for one hectare citrus orchard

ITEM	YEAR OF OPERATION								
	1	2	3	4	5	6	7	8	TOTAL
Labor Cost	34,237.44	18,723.60	20,595.96	22,655.56	24,921.71	27,413.73	30,155.40	33,170.49	211,873.88
Supplies and Materials	66,468.78	23,035.97	26,490.92	30,464.49	35,033.94	40,288.43	46,331.99	38,422.02	306,536.54
Equipment	11,145.00	12,816.75	14,739.63	16,950.80	19,493.35	22,417.80	25,780.61	29,647.19	152,991.13
TOTAL	111,851.22	54,576.32	61,826.52	70,070.84	79,448.99	90,119.96		101,239.69	671,401.55

ANNEX 1: Fertilization in Orchard for Each Application

AGE OF CITRUS TREE (years)	NITROGEN, (N) g/tree	PHOSPHORUS, (P_2O_5) g/tree	POTASSIUM, (K_2O) g/tree
4	150	100	100
5	225	140	200
6	300	200	300
7	400	200	360
8	500	200	420

ANNEX 2a: Common Insect Pests of Citrus in the Cordillera Highlands

PEST	DAMAGE	PERIOD OF OCCURENCE	MANAGEMENT
A. INSECT PESTS			
Aphids *(Toxoptera atricidae)*	• Infests the young shoots, leaves and flower • Bends the young shoots • Curls the leaves, which turns yellowish • Under severe infestation, leaves fall	• Any season • Rampant during dry season when young shoots are developing	• Foliar spray with registered insecticide when young shoots are starting to develop and during flowering season. Follow approved label instructions.
Purple scale insects (*Lepidosaphes beckii Newman*)	• Sticks on the stem, leaves, and developing fruits • Sucks the sap of the infested parts • Results to yellowing of leaves • Glossy appearance of the leaves disappear and become either brownish or bronze	• Any season	• Foliar spray with any registered systemic and contact insecticide following manufacturer's instruction and dosage at the early stage of occurrence. • Ensures full exposure of the trees to sunlight to minimize the insect.

	• Results in stunted growth and the fruits become brownish to blackish in color		
Citrus white flies (*Dialeurodes citri Ashwead*)	• Tiny nymphs suck the sap from the infested parts • Honeydew excreted by the adult cause black sooty mold • Black sooty mold cover the leaves and fruits inhibiting photosynthesis • Results in fruit discoloration	• All season • Rampant during the regular fruiting season	• Foliar spray with 2% oil emulsion or Motor Oil No. 10. • A ratio of 2:8 oil and water using powdered laundry soap as emulsifier can also be used.
Leaf miners	• Injures the plant by tunneling the underside of the young leaves • Results to curling, yellowing, and dropping of the leaves	• All season	• Foliar spray with any registered systemic insecticide. Follow approved label instructions.

PEST	DAMAGE	PERIOD OF OCCURENCE	MANAGEMENT
A. INSECT PESTS			
Red mites (*Panonychus citri*)	• Extracts sap from the leaves, fruits and young stem by piercing and sucking • Results to the appearance of grayish spots on the infested part • Photosynthesis is inhibited resulting to starvation of the plant, suspended growth and poor fruit quality	• Prolonged dry period	• Foliar spray with oil emulsion or with any registered acaricide. • Follow manufacturer's recommended rate of mixture.
Rust mites (*Phyllocoptruta oleivora*)	• Feeds on the sap of leaves, young stems and developing fruits of all types of citrus • More rampant on sweet oranges and mandarin	• During dry periods	• Regular foliar spray with registered acaricide mixed with sulfur-based fungicide. • Follow manufacturer's recommended rate of mixture.

Orange caterpillars or table orange dogs (*Papilio crespoites*)	• Larvae chews the young leaves leaving only the twigs • Transfers to another shoot where they can feed on	• All season • Severe during the period of new shoot flush	• Foliar spray with any registered contact or systemic insecticide. Follow manufacturers instruction and dosage application.

ANNEX 2b. Common Diseases of Citrus in the Cordillera Highlands

DISEASE	DAMAGE	PERIOD OF OCCURENCE	MANAGEMENT
B. DISEASE			
Powdery mildew (*Oidium tingitanum*)	• Grayish and powdery-looking fungus infects the leaves and twigs of shoot • Results in discoloration from normal green to black followed by yellowing and deformation • Severe infection results in dropping of leaves that causes suppression of growth • Results in stunted and distorted leaves while reducing the marketability of the fruits because of the lesions	• Occurs during dry season when morning dew prevails and during short daylight	• Foliar spray with registered sulfur-based fungicides at the very early stage of the fungus occurrence. • As preventive measure, spray at the early start of the flush with an interval of 10-14 days until the end of flush period.

Black sooty mold (*Capnodium citri*)	• Grows on honeydew excreted by the larvae of either the whitefly or scale insect • Black patches appears on both upper and lower portions of the leaf • Inhibits photosynthesis • Results in delayed growth due to dropping of infected leaves	• All season • Rampant during dry season	• Apply control measure for whitefly and scale insect to prevent occurrence of black sooty mold. • Foliar spray or dust with lime sulfur or any other registered sulfur - based fungicide at the early stage of infection at 14-20 interval.
Rusting or silvering of citrus fruits (posible causes are mites and fungus	• Fruit surface discolor with shades of grayish and brownish to almost black margins • Bark of the stem above the ground • Appearance of brownish gum exuded very near the infected trunk or stem	• Fruit season • Rampant during dry period	• Control mites.
Foot rot (*Phytoplothora citrophithora Leonian*)	• Expansion of the gummous area beneath the bark (cambium layer) beyond the dead portion	• Rampant just after a period of heavy rains	Preventive measures include: • use of resistant root stock varieties such as Trifoliate orange or sour orange;

DISEASE	DAMAGE	PERIOD OF OCCURENCE	MANAGEMENT
B. DISEASE			
	• Drying and cracking of the bark followed by severe yellowing of the whole tree of the infected branch		• budding should be done to about 12-18 inches high; • avoid very thick soil cover during transplanting; ensure that the soil cover should not be higher than the root collar; and • avoid excessive water at the base of the tree when irrigating.
Blue mold (*Penicillium italicum Wehmer*)	• Damage starts with a grayish to whitish margin of powdery-looking fungus on the infected portion of the fruit • Fungus easily sticks with nearby fruits	Rampant during high humid conditions	• Do not harvest when fruits are wet. • Avoid injury during harvesting and postharvest. • Remove infected fruits from storage. • Do not overpack in containers.

			• Immerse fruits for 2-3 minutes into 0.5% solution of any appropriate detergent heated at about 100°F.
Green mold (*Penicillium digitatum Sacc.*)	• The mold appears green • Damage is similar to blue mold, however, the green mold does not spread by contact unless the other fruit is injured • Fungus is concentrated in individual fruits • Infected surface of the fruit is firm	Any season or period in storage and on the field	Management is the same with that of the blue mold.
Trizteza virus of Quick decline	• Characterized by the clearing of veinlets of young leaves, prominent stem pitting in many sus ceptible varieties, rapid deterioration of vigor • Infected trees do not re spond to fertilizer application	All season	• Use resistant wood stock • Collect bud wood from virus-free and healthy mother plants. • Remove and burn all infected trees • Control aphids that may transmit the virus.

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About the Subject Matter Specialists

Nelson O. Buayan

Nelson O. Buayan started as a casual laborer in 1977 at the Special Agroforestration Project of the then Mountain State Agricultural College (MSAC), now BSU. In 1980, he worked under the supervision of Dr. Alfredo C. Tipayno in establishing the Pomology Project. He was in charged in the management of the project until November 2007 when he returned to the Institute of Highland Farming Systems and Agroforestry (IHFSA). He acknowledged that most of his acquired knowledge on citrus production is from Benguet State University through the researches that they conducted. In addition, he was also able to learn from the Japanese Overseas Volunteer Corps (JOVC) and the US Peace Corps volunteers. Applying the knowledge he gained, Mr. Buayan was able to establish his own citrus farm.

With his vast knowledge and experience, Mr. Buayan also served as resource person on citrus production trainings conducted by the University in the locality. Now retired, Mr. Buayan is being tapped as consultant by citrus growers in different places like Ifugao, Mt. Province, Kalinga, and Nueva Vizcaya.

Adolfo N. Bilag

At a young age of 16, Adolfo N. Bilag started as a casual laborer in 1979 of the then Mountain State Agriculture College (MSAC), now BSU. Mr. Bilag claimed that most of his knowledge on citrus production was gained from his own observations and self-learning. He was also able to enhance his skills on citrus production when he became a trainee in Kumamoto Prefecture in Japan from April 1992 to March 1993. He also learned from his brother, who is a citrus propagator. At present, Mr. Bilag leads in the management of the citrus orchard at the Institute of Highland Farming Systems and Agroforestry (IHFSA). He said that venturing into citrus production can be a source of extra income because of the high demand for planting materials and fresh fruits.

About the Writers

Von Y. Amado

Von Y. Amado finished his BS Agriculture (major in Extension Education) at the Benguet State University. He is a licensed Agriculturist. He worked as a job-order Research Assistant and later as a farm worker, at the Institute of Highland Farming Systems and Agroforestry (IHFSA) from 2008 to 2014. Currently, he serves as Science Research Assistant of the Institute assisting in the formulation and implementation of various researches primarily on Arabica coffee production and postharvest processing and agroforestry including citrus.

Loida B. Malucay

Loida B. Malucay is a licensed Agriculturist and a graduate of BS Agriculture major in Soil Science at the Benguet State University. She served as a Research Assistant of the Institute of Highland Farming Systems and Agroforestry (IHFSA) from 2009 to 2016 helping in the various researches on Arabica coffee, citrus and agroforestry. At present, she works as an Administrative Assistant of the same Institute.

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