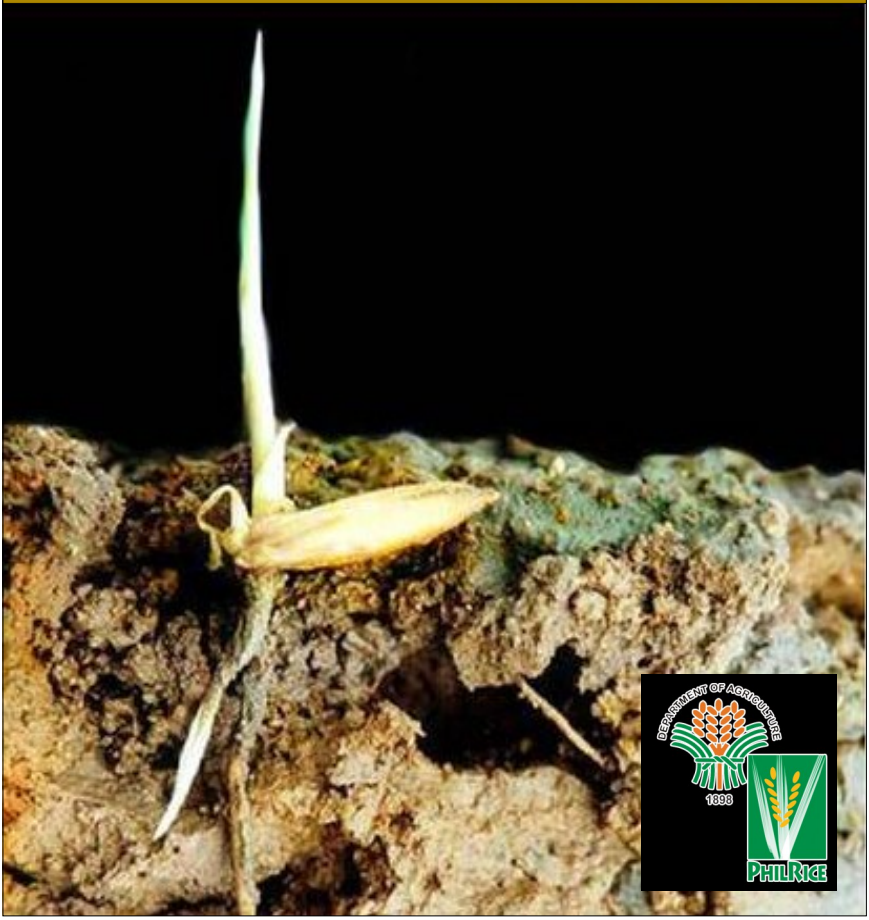
SIMPLIFIED Keys to SOIL SERIES

Oriental Mindoro



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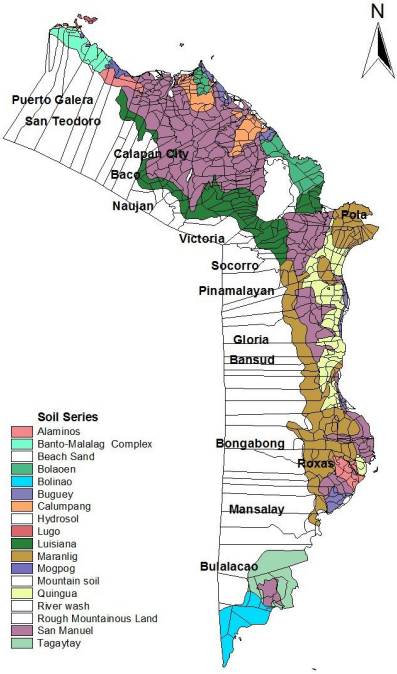

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FOREWORD

This guidebook on “Simplified Keys to Soil Series” was developed for easier field identification of soils.

Soil identification is an important component in rice farming. When the soil is properly analyzed and identified, the risks of incompatible management recommendations will be lessened and selection of knowledge and technologies to apply will be efficient.

This is a good guide for effective nutrient management, which is one of the components of the PalayCheck® System, a dynamic rice crop management system that presents easy-to-follow practices to achieve respective Key Checks and improve crop yield and input-use efficiency.

It features the different colors, textures, pH, and other observable properties of the most common soils of Oriental Mindoro and contains four simple steps in identifying the soil series right in the field. It also includes the soil productivity index, soil properties that affect crop growth, soil taxonomic classification, crop suitability analysis, and soil management recommendations. The concept of simplified keys to soil series was first used in Thailand. In the Philippines, the project “Simplification of the Philippine Soil Series for Rice and Corn” started in 2005 under the Nutrient Management Support System (NuMASS) to provide management recommendations for soils identified in the field.

We thank the farmers, agricultural technologists, and municipal and provincial agriculturists for helping us validate the soil series. We also acknowledge the Bureau of Soils and Water Management (BSWM) for providing the secondary data of the soils used in this guidebook.

SAILILA E. ABDULA

Acting Executive Director

The Simplified Keys to Soil Series

The “Simplified Keys to Soil Series” is a tool to identify soil series in the field following simple steps for the use of farmers, extension workers, agricultural technologists, researchers, and other stakeholders. Using this guidebook, identification of soil will be more accurate reducing the risk of incompatible management and technology recommendations. Selection of knowledge and technologies could also be easy and efficient with the identification of soil series. For instance, because some soil series behave similarly, the management practices and technology suitable in known soil names are expected to be adaptable in the same soil series of a different region.

This guidebook is easy to use. Using only five basic soil properties (color, texture, pH, coarse fragments, and mottles) at 30-50cm soil depth and following the simple steps provided, the soil series in the field could be identified. Once the soil is known, a compilation of thematic information related to the use of soils especially in crop production such as selection of suitable crops, crop productivity ratings, soil properties that limit production, and soil management recommendations can be determined.

Twelve soil series found in Oriental Mindoro are included in this guidebook: Alaminos, Bolaoen, Bolinao, Buguey, Calumpang, Lugo, Luisiana, Maranlig, Mogpog, Quingua, San Manuel, and Tagaytay series.

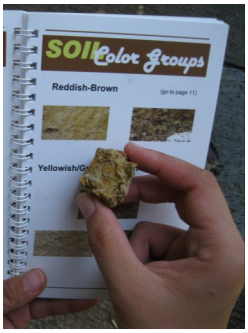
GUIDE TO SOIL SERIES IDENTIFICATION

1 Conduct preliminary interview on the historical background of your sampling site. Gather information on cultivation practices, natural occurrences such as flood, erosion, and human activities that affect the condition and structure of the soil. Check whether the soil was disturbed or scraped.

2 From a vacant area of your identified site, dig a pit or use an auger to get the soil samples needed.

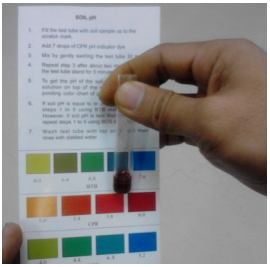
3 Soil samples should be taken from a recommended soil depth to make sure that the condition and structure of the soil is well-preserved and free from any kind of cultivation (see page 45).

4 Know the color of the soil. *Color* is one of the most important physical properties of the soil as indicative to series recognition. Each soil series has its distinct inherent color which makes it different from the other series (see page 46).



5 Identify the texture of the soil. *Texture* is a unique property used as qualitative classification tool to determine classes of soil (see page 47).

6 Determine the soil pH. The measure of acidity or alkalinity in soils is known as *soil pH*. This measurement corresponds to specific soil series (see page 48).



7 Take note of other observable soil properties such as polished surfaces (cutans/slickensides), softness, hardness, stickiness, etc.

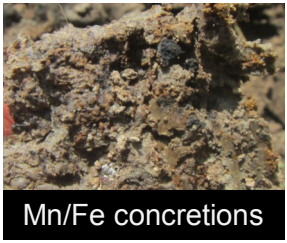

slickenside


mottles

8 Take note of the presence or absence of coarse fragments such as limestone, rock fragments, lateritic nodules, black manganese (Mn) and red iron (Fe) concretions, sand materials, and other observable properties of the soil taken from surfaces up to 50-cm depth.

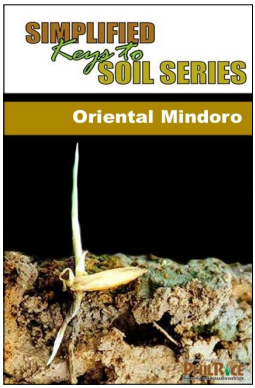

Lateritic nodules


Lateritic nodules


Mn/Fe concretions


Quartz

9 Use the Simplified Keys to Soil Series Guidebook and compare all soil properties starting from the color until the soil name is identified.



SOIL Color Groups

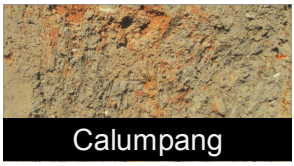
Yellowish Red (go to page 7)

Alaminos

Dark Yellowish Brown (go to page 7)

Maranlig

Dark/Grayish Brown (go to pages 8-9)



Calumpang

Buguey

San Manuel

Tagaytay

SOIL Color Groups

Strong Brown (go to page 10)

Bolaoen

Mogpog

Yellowish Brown (go to pages 11-12)

Bolinao

Lugo

Luisiana

Quingua

Yellowish Red

Texture: Clay loam/Silty clay

Alaminos	(figure on page 14)
Coarse fragments	Gravels; soft weathered basalt
pH	4.5-5.5
Other features	Fe concretion; yellowish red mottles

Dark Yellowish Brown

Texture: Clay

Maranlig	(figure on page 21)
Coarse fragments	Gravels and stones of various sizes and shapes
pH	5.6-6.3
Other features	Hard and compact when dry

Dark/Grayish Brown

Texture: Sand

Buguey	(figure on page 17)
Coarse fragments	Few marine shells in some places
pH	5.3-5.8
Other features	None; structureless

Texture: Clay/Clay loam/Sandy clay loam

Calumpang	(figure on page 18)
Coarse fragments	None
pH	5.2-5.3
Other features	Grayish brown to yellowish red mottles

Dark/Grayish Brown

Texture: Clay loam/Loam/Silt loam

San Manuel	(figure on page 24)
Coarse fragments	None
pH	5.2-7.5
Other features	Slightly compact; yellowish brown mottles

Texture: Clay/Clay loam

Tagaytay	(figure on page 25)
Coarse fragments	Gravels
pH	6.6-8.3
Other features	Compact; exhibits cracking

Strong Brown

Texture: Clay loam

Bolaoen	(figure on page 15)
Coarse fragments	Plenty of gravels
pH	6.0-6.5
Other features	Embedded boulders; Fe concretions

Texture: Clay loam

Mogpog	(figure on page 22)
Coarse fragments	None
pH	4.7-5.0
Other features	Reddish brown splotches; black powdery concretions

Yellowish Brown

Texture: Clay

Bolinao	(figure on page 16)
Coarse fragments	Weathered limestone gravels
pH	5.0-7.5
Other features	Brownish mottles; compact

Texture: Clay/Silty clay

Lugo	(figure on page 19)
Coarse fragments	Consolidated shales
pH	4.5-5.5
Other features	Red spot mottles; limestone outcrops

Yellowish Brown

Texture: Clay

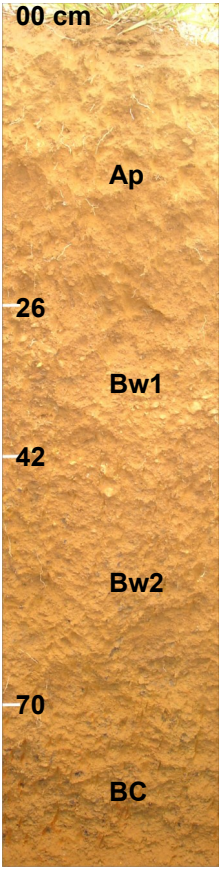
Luisiana	(figure on page 20)
Coarse fragments	None
pH	4.5-5.5
Other features	Reddish streaks and yellow splotches; friable and mellow

Texture: Clay loam/Silt loam/Silty clay loam

Quingua	(figure on page 23)
Coarse fragments	None
pH	6.0-7.8
Other features	Reddish brown streaks on low-land rice; slightly compact

SOIL Profile and Characteristics

Alaminos



Soil Fertility Indicators	
Inherent fertility	Low
Soil pH	Acidic (4.5-5.5)
Organic matter	Moderate
Phosphorus (P)	Low
Potassium (K)	Low
Nutrient retention (CEC)	Low
Base saturation	Low
Salinity hazard	None

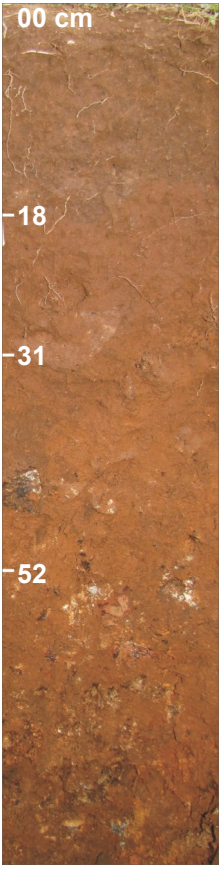
Physical Soil Qualities	
Relief	Slightly rolling to hilly and mountainous
Water retention	Moderate
Drainage	Good to excessive
Permeability	Moderate to rapid
Workability/tilth	Moderate
Stoniness	Highly weathered rock outcrops; boulders; serpentine rocks; gravels; iron concretions
Root depth	Deep (>1m)
Erosion	Moderate

Soil Type: Clay loam/Silty clay loam **Area:** 4,927.66 ha

Family: Fine loamy, mixed, isohyperthermic, *Typic Paleudults*

A fine-textured soil with no particular mineral that dominates (**mixed**) and has an isohyperthermic temperature regime (**22°C**). This is a typical representative of the great group **Paleudults** which means there is vertical clay distribution in which the clay content does not decrease by as much as 20% from the maximum clay content (**Pale**-) and is found in areas with well-distributed rainfall (-**ud**, **udic**). It is an old soil which has undergone an extensive leaching of bases, acidic, relatively low in fertility, and has an accumulation of clay in the subsoil (-**ult**, **Ultisol**).

Bolaoen



Soil Fertility Indicators	
Inherent fertility	Low
Soil pH	Slightly acid (5.5-6.5)
Organic matter	Low
Phosphorus (P)	Low
Potassium (K)	Low
Nutrient retention (CEC)	Low
Base saturation	Low
Salinity hazard	None

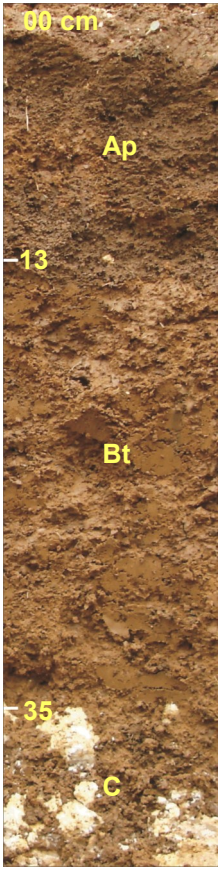
Physical Soil Qualities	
Relief	Flat upland to undulating to rolling
Water retention	High
Drainage	Moderate
Permeability	Moderate
Workability/tilth	Moderate
Stoniness	Gravels; Fe concretions; gabbro rocks at lower strata
Root depth	Deep (1m)
Erosion	Slight to severe

Soil Type: Clay loam **Area:** 8,221.64 ha

Family: Fine, mixed, isohyperthermic, *Typic Haplustults*

A fine-textured soil with no particular mineral that dominates (**mixed**). It has an isohyperthermic temperature regime (**>22°C**). It is a typical representative of the great group Haplustults which exhibits minimum complexity in its horizonation (**Hapl**-) and is found in areas with pronounced wet and dry seasons (-**ust**, **ustic**). It is an old soil which has undergone an extensive leaching of bases, relatively low in fertility, and accumulation of clay in the subsoil (-**ult**, **Ultisol**).

Bolinao



Soil Fertility Indicators	
Inherent fertility	Moderate
Soil pH	Slightly acid to neutral (5.5-7.2)
Organic matter	Low
Phosphorus (P)	Low to moderate
Potassium (K)	Low
Nutrient retention (CEC)	High
Base saturation	Moderate
Salinity hazard	None

Physical Soil Qualities	
Relief	Rolling to hilly
Water retention	High
Drainage	Moderate
Permeability	Moderate
Workability/tilth	Moderate
Stoniness	Limestone gravels; boulder outcrops
Root depth	Shallow to moderate (0.4-0.8m)
Erosion	Slight

Soil Type: Clay/Clay loam/Silty clay loam **Area:** 8,010.36 ha

Family: Fine clayey, montmorillonitic, isohyperthermic, *Typic Hapludalfs*

A fine clayey-textured soil dominated by minerals with high shrink and swelling capacity (**montmorillonitic**). It has a mean annual soil temperature of higher than 22°C (**isohyperthermic**). This is a typical representative of the great group **Hapludalfs** which exhibits minimum complexity in its horizonation (**Hapl**-) and is found in areas with well-distributed rainfall (-**ud**, **udic**). This is an old soil that exhibits illuvial accumulation of clay in the subsoil from the underlying horizons and has retained high base status (-**alf**, **Alfisol**).

Buguey

Soil Fertility Indicators	
Inherent fertility	Low
Soil pH	Strong to slightly acid (5.0-5.6)
Organic matter	Low
Phosphorus (P)	Low
Potassium (K)	Low
Nutrient retention (CEC)	Low
Base saturation	Moderate
Salinity hazard	None

Physical Soil Qualities	
Relief	Level to slightly undulating
Water retention	Low
Drainage	Good to excellent
Permeability	Rapid
Workability/tilth	Easy
Stoniness	Few marine shells in the upper subsoil
Root depth	Deep (>1m)
Flooding	None

Soil Type: Loamy sand **Area:** 4,735.25 ha

Family: Mixed, isohyperthermic, *Typic Udipsamments*

A sandy-textured (**>60%**) soil developed from coastal deposits with no particular mineral that dominates (**mixed**). Has isohyperthermic (**>22°C**) temperature regime. It is a typical representative of the great group **Udipsamments**. This soil is dominantly sandy (**Psamm** -) in texture occurring in areas with well-distributed rainfall (-**ud**, **udic**). It is a young soil with little or no development and properties are determined largely by parent materials (-**ent**, **Entisol**).

Calumpang

Soil Fertility Indicators	
Inherent fertility	Moderate
Soil pH	Moderately acid (5.7-6.2)
Organic matter	Moderate
Phosphorus (P)	High
Potassium (K)	High
Nutrient retention (CEC)	Moderate
Base saturation	Moderate
Salinity hazard	None

Physical Soil Qualities	
Relief	Level to slightly undulating
Water retention	Moderate
Drainage	Poor
Permeability	Moderate
Workability/tilth	Easy
Stoniness	Few fine and medium gravels
Root depth	Moderate (0.6m)
Flooding	Seasonal

Soil Type: Clay loam/Silty clay loam **Area:** 7,474.45 ha

Family: Fine clayey, mixed, isohyperthermic, *Fluventic Endoaquepts*

A fine clayey-textured soil with no particular mineral that dominates (**mixed**). It has an isohyperthermic temperature regime (**>22°C**) and found in flood plains, hence subjected to seasonal flooding (**fluventic**). It is a representative of great group **Endoaquepts**. It is wet throughout the profile (**endo**-) and is saturated with water for repeated periods of time (**aqu**-) manifested by grayish color. It is a young soil in its incipient development stage toward a mature soil but has not yet fully developed its diagnostic horizons (-**ept**, **Inceptisol**).

Lugo

Soil Fertility Indicators	
Inherent fertility	High
Soil pH	Slightly acid (5.0–6.5)
Organic matter	High
Phosphorus (P)	Low
Potassium (K)	Moderate
Nutrient retention (CEC)	High
Base saturation	High
Salinity hazard	Low

Physical Soil Qualities	
Relief	Slightly rolling to rolling
Water retention	Moderate
Drainage	Poor
Permeability	Slow
Workability/tilth	Hard to moderate
Stoniness	Few weathered shale
Root depth	Moderate (0.5 m)
Erosion	Moderate
Flooding	None

Soil Type: Clay **Area:** 2,425.82 ha

Family: Fine clayey, mixed, isohyperthermic, *Typic Eutrudepts*

A fine clayey-textured soil developed from calcareous shale with no particular mineral that dominates (**mixed**). It has an isohyperthermic temperature regime (**>22°C**). It is a typical representative of great group **Eutrudepts**, having a high base saturation (**Eutr**-) and is found in areas with well-distributed rainfall (-**ud**, **Udic**). It is a young soil in its incipient development stage toward a mature soil but has not yet fully developed its diagnostic horizons (-**ept**, **Inceptisol**).

Luisiana

Soil Fertility Indicators	
Inherent fertility	Low
Soil pH	Acidic (4.0 - 5.5)
Organic matter	Moderate
Phosphorus (P)	Low
Potassium (K)	Low
Nutrient retention (CEC)	Moderate
Base saturation	Low
Salinity hazard	None

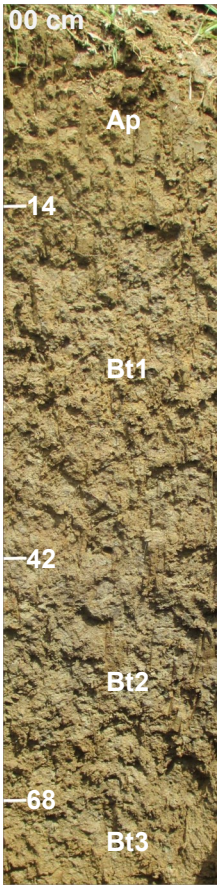
Physical Soil Qualities	
Relief	Rolling to mountainous
Water retention	High
Drainage	Good
Permeability	Moderate
Workability/tilth	Moderate
Stoniness	None
Root depth	Very deep (1.0-1.5m)
Erosion	Slight to moderate
Flooding	None

Soil Type: Clay/Clay loam **Area:** 24,481.77 ha

Family: Fine clayey, acidic, kaolinitic, isohyperthermic, *Typic Paleudults*

A fine clayey-textured soil (**18-35% clay**) dominated by non-expanding type of clay minerals kaolinite (**kaolinitic**). It has an isohyperthermic (**>22°C**) temperature regime. This soil is a typical (**typic**) representative of the great group **Paleudults**. There is vertical clay distribution in which clay content does not decrease by as much as 20% from the maximum clay content (**Pale**-). It is found in areas with well-distributed rainfall (-**ud**, **udic**). This is an intensely weathered soil with accumulation of clay in its underlying horizon, acidic, and has a low base status (-**ult**, **Ultisol**).

Maranlig



Soil Fertility Indicators	
Inherent fertility	Low
Soil pH	Slightly acid (5.7-6.2)
Organic matter	Moderate
Phosphorus (P)	Low
Potassium (K)	Low
Nutrient retention (CEC)	Low
Base saturation	Low
Salinity hazard	None

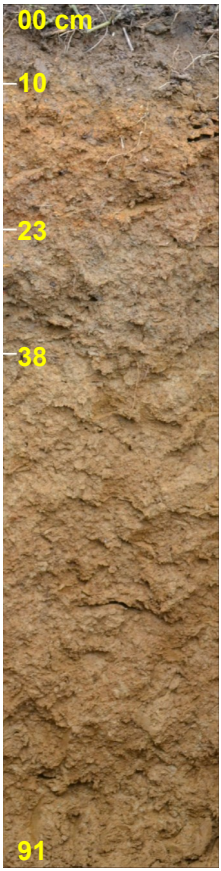
Physical Soil Qualities	
Relief	Undulating to rolling and hilly
Water retention	Poor to moderate
Drainage	Moderate
Permeability	Moderate to rapid
Workability/tilth	Moderate
Stoniness	Gravels and stones of various sizes and shapes
Root depth	Shallow (0.45m)
Erosion	Slight to moderate

Soil Type: Clay/Loam/Sandy clay loam **Area:** 39,331.83 ha

Family: Fine, isohyperthermic, *Typic Haplustults*

A fine-textured soil with isohyperthermic (**>22°C**) temperature regime. It is a typical representative of the great group **Haplustults** that exhibits minimum complexity in its horizonation (**Hapl**-) and is found in areas with pronounced wet and dry seasons (-**ust**). This is an old soil which has undergone an extensive leaching of bases, acidic, relatively low in fertility, and has an accumulation of clay in the subsoil (-**ult, Ultisol**).

Mogpog



Soil Fertility Indicators	
Inherent fertility	Moderate
Soil pH	Strongly acid (4.8-5.0)
Organic matter	Low
Phosphorus (P)	Moderate
Potassium (K)	Low
Nutrient retention (CEC)	Moderate
Base saturation	Moderate
Salinity hazard	None

Physical Soil Qualities	
Relief	Level to nearly level
Water retention	High
Drainage	Poor
Permeability	Moderate
Workability/tilth	Easy
Stoniness	Manganese concretions
Root depth	Deep (>1m)
Erosion	None
Flooding	None to seasonal

Soil Type: Clay loam **Area:** 916.80 ha

Family: Fine loamy, mixed, isohyperthermic, *Typic Eutrudepts*

Fine loamy-textured soil with no particular mineral that dominates (**mixed**). It has an isohyperthermic temperature regime (**>22°C**). It is a typical representative of great group **Eutrudepts**, having a high base saturation (**Eutr**-) and is found in areas with well-distributed rainfall (-**ud**, **Udic**). This is a young soil in its incipient development stage toward a mature soil but has not yet fully developed its diagnostic horizons (-**ept**, **Inceptisol**).

Quingua

Soil Fertility Indicators	
Inherent fertility	Moderate
Soil pH	Slightly acid to neutral (5.5-7.5)
Organic matter	Low
Phosphorus (P)	Low
Potassium (K)	Moderate
Nutrient retention (CEC)	High
Base saturation	High
Salinity hazard	Low

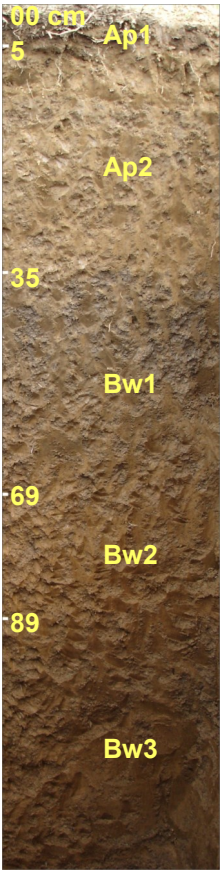
Physical Soil Qualities	
Relief	Level to slightly undulating
Water retention	Moderate
Drainage	Moderate to good
Permeability	Moderate
Workability/tilth	Easy
Stoniness	None
Root depth	Deep (>1m)
Flooding	Seasonal

Soil Type: Clay/Clay loam/Loam/ Sandy loam/Silt loam/Silty clay **Area:** 16,667.12 ha

Family: Fine loamy, mixed, isohyperthermic, *Typic Hapludalfs*

Fine loamy-textured soil with moderate amount of clay (**18-35%**) and with no particular mineral that dominates (**mixed**). It has an isohyperthermic temperature regime (**>22°C**). This is a typical representative of the great group **Hapludalfs** which exhibits minimum complexity in its horizonation (**Hapl**-) and is found in areas with well-distributed rainfall (-**ud**, **udic**). It is an old soil which has undergone extensive weathering but has retained a high base status in its horizon (-**alf**, **Alfisol**).

San Manuel



Soil Fertility Indicators	
Inherent fertility	Moderate to high
Soil pH	Slightly acid to neutral (5.5 - 7.2)
Organic matter	Moderate
Phosphorus (P)	Moderate
Potassium (K)	Moderate
Nutrient retention (CEC)	High
Base saturation	High
Salinity hazard	None

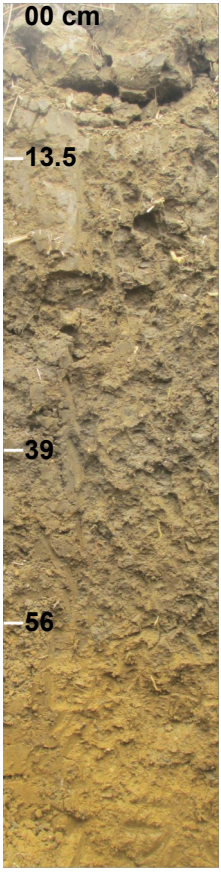
Physical Soil Qualities	
Relief	Level to nearly level
Water retention	Moderate
Drainage	Moderate to good
Permeability	Moderate
Workability/tilth	Easy
Stoniness	None
Root depth	Deep (>1 m)
Flooding	Seasonal by river water during rainy season

Soil Type: Clay loam/Loam/Loamy sand/ Sandy loam/Silt loam **Area:** 76,713.67 ha

Family: Fine loamy, mixed, isohyperthermic, *Typic Haplustepts*

Fine loamy-textured soil with no particular mineral that dominates (**mixed**). It has an isohyperthermic (**>22°C**) temperature regime. It is a typical representative of the great group **Haplustepts** which exhibits minimum complexity in its horizonation and is found in areas with pronounced wet and dry seasons (-**ust**,). This is a young soil in its incipient development stage toward a mature soil but has not yet fully developed its diagnostic horizons (-**ept**, **Inceptisol**).

Tagaytay



Soil Fertility Indicators	
Inherent fertility	Moderate
Soil pH	Slightly acid to moderately alkaline (6.6-8.7)
Organic matter	Low
Phosphorus (P)	High
Potassium (K)	Low
Nutrient retention (CEC)	Moderate
Base saturation	Moderate
Salinity hazard	None

Physical Soil Qualities	
Relief	Rolling to hilly
Water retention	Moderate
Drainage	Moderate to good
Permeability	Moderate
Workability/tilth	Easy
Stoniness	Common fine gravels
Root depth	Moderate (0.8m)
Erosion	Slight

Soil Type: Sandy loam **Area:** 10,999.59 ha

Family: Fine loamy, mixed, isohyperthermic, *Typic Haplustepts*

A fine loamy-textured soil developed from volcanic rocks with no particular mineral that dominates (**mixed**). It has an isohyperthermic temperature regime (**>22°C**). This is a typical representative of great group **Haplustolls** which exhibits minimum complexity in its horizonation (**Hapl**-) and is found in areas with pronounced wet and dry seasons (-**ust**). This is a young soil in its incipient development stage toward a mature soil but has not yet fully develop its diagnostic horizons (-**ept**, **Inceptisol**).

SOIL Productivity

Soil productivity is the quality that summarizes soil potential in producing plants or sequences of plants under defined sets of management practices. It is also a synthesis of conditions of soil fertility, water control, plant species, soil tilth, pest control and physical environment (Bainroth, 1978: Badayos, 1990). In economic terms, it is a measure of the amount of inputs of production factors required to correct soil limitation(s) to attain a certain level of production. It is expressed as average crop yield under defined sets of management classes (Badayos, 1990).

Soil productivity index is used for making comparisons among soils; categorized into inherent and potential. Inherent productivity is the natural capacity of the soil to produce a given yield; potential refers to its capacity to produce yield after correctible soil constraints had been remedied. In economics, the predicted inherent yield is calculated by multiplying the inherent index by the maximum potential yield (MPY) of rice; predicted maximum possible yield is computed by multiplying the potential index by the MPY. For instance, MPY in the dry season is 8 tons/ha, and inherent and potential productivity ratings for Alaminos series are 0.22 and 0.32, respectively. The predicted inherent and potential yields of rice in Alaminos soils are then 1.76 and 2.56 tons/ha.

Table 1. Soil productivity index for rice.

Soil Series	Inherent Productivity	Potential Productivity
Alaminos	0.22	0.32
Bolaoen	0.45	0.55
Bolinao	0.62	0.72
Buguey	0.26	0.51
Calumpang	0.42	0.55
Lugo	0.70	0.80
Luisiana	0.17	0.37
Maranlig	0.45	0.55
Mogpog	0.67	0.77
Quingua	0.65	0.75
San Manuel	0.62	0.72
Tagaytay	0.49	0.59

CROP Suitability Analysis

Soil suitability classification refers to the use of a piece of land on a sustainable basis based on physical and chemical properties and environmental factors. It is the ultimate aim of soil survey and may come up through a good judgment and thorough evaluation of soil properties and qualities such as depth, texture, slope, drainage, erosion, flooding, and fertility. Based on these soil properties, the suitability of a certain tract of land for crop production can be determined.

Suitability ratings denote qualitative analysis of the potential of the soil to grow different crops. They imply what crop(s) would give the highest benefit in terms of productivity and profitability from a given soil type, indicated by S1 as the most suitable down to S3 as marginally suitable. The symbol N implies that the crop is either currently not suitable (N1) where the effect of limitation is so severe as greatly to reduce the yield or to require costly inputs, or permanently not suitable (N2) where the limitations cannot be corrected permanently. Crop suitability analysis also provides information on soil properties that limit the production of specified crop(s).

When using a parametric system, the soil index can be equated into percentages shown below. It means that you can attain 75% of the potential crop yield when the soil index is highly suitable; less than 25% of the potential yield when the soil index is not suitable.

S1: soil index >75
S2: soil index 50-75
S3: soil index 25-50
N: soil index <25

Table 2a. The crop suitability ratings for different soil series of Oriental Mindoro.

Philippines Top Agricultural Commodity	SOIL SERIES					
	Alaminos	Bolaoen	Bolinao	Buguey	Calumpang	Lugo
Sugarcane	S3ctwf	S2ctsf	S2ctf	S2cwsf	S2cwsf	S2ctw
Rice Irrigated Lowland	N2	N2	N2	S3twsf	S2tf	N2
Rice Rainfed Upland	S2twf	S2tsf	S2tsf	S2sf	S3wsf	S2tw
Rice Rainfed Lowland	S3ctws	S3ctwsf	S3ctwsf	S3cwsf	S2cws	S2cts
Coconut	S2twf	S1ts	S2t	S1	N1wsf	N1tws

Suitability Ratings:

S1 - Highly suitable

S2 - Moderately suitable

S3 - Marginally suitable

N1 - Currently not suitable

N2 - Permanently not suitable

Limitations due to:

t - Topography; slope

w - Drainage; flooding

s - Texture; coarse fragments; soil depth

f - Soil fertility

c - Climate

Table 2a. The crop suitability ratings for different soil series of Oriental Mindoro (continuation) .

Philippines Top Agricultural Commodity	SOIL SERIES					
	Luisiana	Maranlig	Mogpog	Quingua	San Manuel	Tagaytay
Sugarcane	S2ctwf	S2cts	S2cw	S2ctwf	S2cwf	S2ctwsf
Rice Irrigated Lowland	N2	N2	S2sf	S2tsf	S2sf	N2
Rice Rainfed Upland	S2tw	S2ts	S3wf	S2w	S2tf	S2tsf
Rice Rainfed Lowland	S3ctwsf	S2ctws	S2cwf	S2cws	S2cws	S3ctwsf
Coconut	S2tw	S2ts	N1wf	S2wf	S2w	S2twf

Table 2b. The crop suitability ratings for different soil series of Oriental Mindoro.

Philippines Top Agricultural Commodity	SOIL SERIES					
	Alaminos	Bolaoen	Bolinao	Buguey	Calumpang	Lugo
Banana	S3ctf	S3ctsf	S3ctf	S3csf	S3cwsf	S3ctwf
Maize	N1ctf	S2ctsf	S3ctf	S3cfs	S3ctfs	S2cts
Pineapple	S3ctf	S3ctwf	S3ctwf	S3cwf	S3cws	N2
Cassava	S2ctf	S2ctwsf	S2ctw	S2csf	N2	N1ctwsf
Mango	N1cf	S2ctsf	S3ctf	S2csf	N1ctwsf	S3ctwf
Camote	S3ctf	S3ctsf	S3ctf	S3csf	S3cwsf	S3ctwsf

Suitability Ratings:

S1 - Highly suitable

S2 - Moderately suitable

S3 - Marginally suitable

N1 - Currently not suitable

N2 - Permanently not suitable

Limitations due to:

t - Topography; slope

w - Drainage; flooding

s - Texture; coarse fragments; soil depth

f - Soil fertility

c - Climate

Table 2b. The crop suitability ratings for different soil series of Oriental Mindoro (continuation).

Philippines Top Agricultural Commodity	SOIL SERIES					
	Luisiana	Maranlig	Mogpog	Quingua	San Manuel	Tagaytay
Banana	S3ctf	S3cts	S3cwf	S2ctw	S3cwf	S3ctsf
Maize	S3ctf	S3cts	S2ctf	S2ctf	S2ctf	S3ctsf
Pineapple	S3cts	S2ctf	S3cts	N2	N2	N2
Cassava	S2ctf	S3ctws	N2	N2	N2	S3ctwsf
Mango	S3ctf	S3cs	S3cwf	S2ctwf	S2cwf	S3ctsf
Camote	S3ctwf	S3ctsf	S3cwf	S3cwf	S3cwf	S3ctwf

Table 2c. The crop suitability ratings for different soil series of Oriental Mindoro.

Philippines Top Agricultural Commodity	SOIL SERIES					
	Alaminos	Bolaoen	Bolinao	Buguey	Calumpang	Lugo
Tomato	S3ctf	S2ctsf	S2ctf	S2cwf	S3ctwsf	S2ctw
Papaya	S3twf	S3ctsf	S3ctw	S3ctf	N2	N1cts
Cabbage	S3ctf	S2cts	S2ctf	S2csf	S3cwsf	S3ctws
Onion	S3ctwf	S3ctws	S3ctw	S3cws	N2	S3ctw
Potato	S3ctwf	S2ctsf	S2ct	S2csf	S3cwf	S2ctws

Suitability Ratings:

S1 - Highly suitable

S2 - Moderately suitable

S3 - Marginally suitable

N1 - Currently not suitable

N2 - Permanently not suitable

Limitations due to:

t - Topography; slope

w - Drainage; flooding

s - Texture; coarse fragments; soil depth

f - Soil fertility

c - Climate

Table 2c. The crop suitability ratings for different soil series of Oriental Mindoro (continuation).

Philippines Top Agricultural Commodity	SOIL SERIES					
	Luisiana	Maranlig	Mogpog	Quingua	San Manuel	Tagaytay
Tomato	S3ctwf	N2	S3cw	S3ctwsf	S2cwf	S2ctsf
Papaya	S3ctf	S3cts	N2	N2	N2	S3ct
Cabbage	S3ctf	S3cts	N2	N2	N2	S3ctf
Onion	S3ctws	S3ctws	N2	N2	N2	N2
Potato	S2ctwf	S2cts	S3cwf	S2cwf	S2cwf	S2ctsf

Table 2d. The crop suitability ratings for different soil series of Oriental Mindoro.

Other Agricultural Commodity	SOIL SERIES					
	Alaminos	Bolaoen	Bolinao	Buguey	Calumpang	Lugo
Beans	S3ctwf	S2ctsf	S3ctsf	S2cf	S3cwsf	S2ctw
Citrus	S2tf	S2twsf	S2tw	S2f	N2	N1twsf
Peanut	N1ctwf	S3ctsf	S3ctwf	S2csf	N2	S3ctwsf
Pineapple	S3ctf	S3ctwf	S3ctwf	S3cwf	S3cws	N2
Sorghum	N2	N2	N2	N2	N2	N2
Tobacco	S3ctwf	S3ctsf	S3ctwf	S3ctwsf	N2	S3ct
Watermelon	S3ctf	S3ctwf	S3ctsf	S2ctsf	S3ctwsf	S3ctwsf

Suitability Ratings:

S1 - Highly suitable

S2 - Moderately suitable

S3 - Marginally suitable

N1 - Currently not suitable

N2 - Permanently not suitable

Limitations due to:

t - Topography; slope

w - Drainage; flooding

s - Texture; coarse fragments; soil depth

f - Soil fertility

c - Climate

Table 2d. The crop suitability ratings for different soil series of Oriental Mindoro (continuation).

Other Agricultural Commodity	SOIL SERIES					
	Luisiana	Maranlig	Mogpog	Quingua	San Manuel	Tagaytay
Beans	N1ctwf	S3cts	N2	S2cw	S2cwf	S2ctwsf
Citrus	S3tsf	N2	N2	N2	N2	S3twsf
Peanut	N1ctwsf	S3ctwsf	N2	N2	N2	S3ctwsf
Pineapple	S3cts	S2ctf	S3cts	N2	N2	N2
Sorghum	N2	N2	N2	N2	N2	N2
Tobacco	S3ctwf	S3ctsf	N2	N2	N2	S3cts
Watermelon	S3ctsf	S3ctwsf	N1cwsf	S3ctwsf	S3cwsf	S3ctwsf

SOIL Management Recommendations

Soil management aims to protect the soil and enhance its performance to increase farm profitability and preserve environmental quality. It is the combination of soil factors to maximize crop production at the lowest possible cost while maintaining the soil's productive state. It involves maintaining the soil in good physical condition and fertility status, and influencing the biological aspect of the soil to attain maximum benefits (Harpstead, et al. 1997).

Soil management recommendations suitable for each soil identified are enumerated in the succeeding pages. Soil factors such as slope, texture, and climate cannot be changed. However, control tillage, crop rotations, soil amendments, and other management choices can be done. Through these choices, the structure, biological activity, and chemical content of the soil can be altered and later on influence erosion rates, pest population, nutrient availability, and crop production.

Table 3. Limitations to crop production and recommended management strategies for different crops when grown in a given soil series.

Soil Series	Limitation for crop production	Soil Management Recommendations			
		Rice	Diversified crops	Root crops	Tree/Forest/ Plantation crops
Alaminos	Sloping topography that causes risk of erosion; acidic; low fertility	Suitable for upland rice production; terracing; liming; addition of adequate fertilizers	Contour farming and/ or strip cropping; addition of organic matter and animal manure; application of adequate fertilizers	Practice contour plowing and minimum tillage to prevent soil erosion; construction of erosion control system	Planting of permanent crops and trees along the contour line to restore soil fertility and minimize erosion; placing fertilizer at the zone of maximum root activity of tree crops
		Cropping Pattern: rainfed upland rice-rootcrops/fruit trees			
Bolaoen	Scattered rock outcrops and boulders; low fertility; slightly acidic; low OM	Suitable for upland rice; application of fertilizers; use of mouldboard plow to manage presence of outcrops and boulders; addition of organic matter to improve fertility	Application of fertilizers; strip cropping; addition of organic matter and animal manure; adequate irrigation system	Production constraints due to presence of boulders and rock fragments in the subsoil thus, clearing of rock outcrops and boulders should be done; contour cropping	Suited for fruit trees, forest, and other hardwood trees e.g. citrus, mango, ipil, molave, coconut, etc.
		Cropping Pattern: upland rice-diversified crops/fruit trees/forest			

Table 3. Limitations to crop production and recommended management strategies for different crops when grown in a given soil series (continuation).

Soil Series	Limitation for crop production	Soil Management Recommendations			
		Rice	Diversified crops	Root crops	Tree/Forest/ Plantation crops
Bolinao	Rolling topography in some areas which causes risk of erosion; shallow rooting depth; low organic matter; low available P	Suitable for rainfed upland rice but needs terracing to control erosion; application of phosphate fertilizers and addition of organic matter to improve fertility	Contour terracing; proper fertilization; proper timing of cultivation and planting; addition of organic matter and animal manure to improve soil fertility; application of phosphate fertilizers	Contour terracing; use of cover crops like Ipil-ipil for soil rehabilitation and source of firewood at the same time; addition of organic matter	Plant trees along contour line to prevent erosion and maintain the fertility of the soil; use of locally adapted tree species and addition of fertilizer for high yield
		Cropping Pattern: upland rice-diversified crops/fruit trees; upland rice-rootcrops			
Buguey	Sandy texture; low fertility; slightly acidic; excessive drainage causes lack of soil moisture	Apply fertilizer to improve the fertility of the soil; construction of adequate irrigation and drainage control systems; green manuring to improve OM and texture	Adequate irrigation system; OM application or green manuring; deep plowing; practice timing of planting; use broad beds and ridges; apply fertilizer to improve the fertility of the soil	Adequate irrigation and drainage control systems; apply fertilizer to improve the fertility of the soil; OM application or green manuring	Coconut farming; adequate fertilization for high yield
		Cropping Pattern: vegetables-rootcrops; coconut			

Table 3. (continuation).

Soil Series	Limitation for crop production	Soil Management Recommendations			
		Rice	Diversified crops	Root crops	Tree/Forest/ Plantation crops
Calumpang	Poor drainage; shallow rooting depth; seasonal flooding; acidic	Flat low-lying areas suited for paddy rice with adequate drainage and flood control systems; apply lime to neutralize the pH	Construction of adequate drainage and flood control systems; use of broad beds; mulching; apply lime to neutralize the pH	Construction of adequate drainage and flood control systems; use of broad beds; construction of ridges or furrows; liming	Construction of adequate drainage and flood control systems; apply lime to neutralize the pH
		Cropping Pattern: rice-rice; rice-diversified crops			
Lugo	Hilly topography; P deficiency; difficult to till due to formation of hard clods; severe soil erosion that depletes the more fertile topsoil	Upland rice farming; terracing to minimize erosion; addition of P fertilizer; OM incorporation	P fertilization; adequate irrigation; OM incorporation to improve tilth; erosion prevention measures e.g. contour terracing/farming	Slightly suitable due to formation of hard clods that may impede growth of root crops; proper tillage and OM incorporation; adequate fertilization; contour farming or strip cropping	Planting of permanent crops and trees along contour line to restore soil fertility and minimize erosion
		Cropping Pattern: upland rice-diversified crops			

Table 3. Limitations to crop production and recommended management strategies for different crops when grown in a given soil series (continuation).

Soil Series	Limitation for crop production	Soil Management Recommendations			
		Rice	Diversified crops	Root crops	Tree/Forest/ Plantation crops
Luisiana	Highly leaches; very acidic; iron and aluminum toxicity; low base saturation and low CEC; runoff; Hilly topography that causes erosion.	Terracing to control erosion; liming; adequate fertilization; OM incorporation	Practice contour farming and cover-cropping; apply adequate fertilization; liming; OM incorporation	OM incorporation to improve fertility and to improve soil structure; practice contour or strip cropping	Planting of permanent crops and trees along contour line to restore soil fertility and minimize erosion; placing fertilizer at the zone of maximum root activity of tree crops
		Cropping Pattern: upland rice - root crops/fruit trees/forest			
Maranlig	Rolling to hilly topography that causes erosion; many stones and gravels throughout the profile; shallow rooting depth; slightly acidic	Terracing can be done to minimize erosion; construction of adequate irrigation system; liming	Practice contour farming or strip cropping to minimize erosion; liming; addition of organic matter	Practice contour plowing and minimum tillage to prevent soil erosion; construction of erosion and irrigation control systems	Upland and hilly land is well-suited for agro-forest, industrial crops, orchard and forest but use locally adapted high-yielding varieties of tree crops
		Cropping Pattern: upland rice - rootcrops/fruit trees			

Table 3. (continuation).

Soil Series	Limitation for crop production	Soil Management Recommendations			
		Rice	Diversified crops	Root crops	Tree/Forest/ Plantation crops
Mogpog	Seasonal flooding; poor drainage; strongly acidic	Construction of flood control system; liming; addition of organic matter	Construction of flood and drainage control systems; use broad beds; liming; addition of organic matter	Adequate drainage and flood control systems; cultivate only at optimum moisture content; construction of broad beds	Establishment of adequate drainage and flood control systems; use of suitable tree species and proper fertilization
		Cropping Pattern: rice-rice; rice-diversified crops			
Quingua	Seasonal flooding; low organic matter	Application of adequate fertilizers to maintain the fertility of the soil; construction of irrigation system; observe flood control measures due to seasonal flooding	Establishment of adequate drainage, irrigation and flood control systems; proper timing of cultivation and planting; OM addition thru green manuring	Construction of adequate drainage irrigation and flood control systems; proper timing of cultivation and planting	Construction of adequate drainage, irrigation and flood control systems
		Cropping Pattern: rice-rice; rice-diversified crops/rootcrops/fruit trees			

Table 3. Limitations to crop production and recommended management strategies for different crops when grown in a given soil series (continuation).

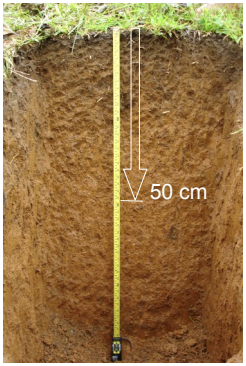
Soil Series	Limitation for crop production	Soil Management Recommendations			
		Rice	Diversified crops	Root crops	Tree/Forest/ Plantation crops
San Manuel	Seasonal river flooding; excessively wet and annual flooding for short periods and excessive drought during dry season	Suited for paddy rice during wet season and with adequate irrigation during dry season; OM addition thru animal or green manuring; construction of flood control system	Construction of adequate drainage, irrigation and flood control systems due to seasonal flood hazard and high seasonal water table; use broad beds and ridges	Establishment of adequate drainage and irrigation systems; regular addition of organic matter and animal manure to improve soil fertility; use broad beds and ridges	Adequate drainage and irrigation system; cover cropping with legumes; proper fertilization; use of locally adapted high-yielding varieties
		Cropping Pattern: rice-rice; rice-vegetables/rootcrops/diversified crops			
Tagaytay	Rolling topography and sandy loam texture that causes risk of erosion; relatively low organic matter; K deficiency	Suited for upland rice; terracing to control erosion; OM addition thru animal or green manuring to improve soil structure	Practice contour and strip farming to minimize runoff; proper fertilization; OM incorporation; use of cover crops to prevent risks of erosion	OM incorporation or green manuring to improve soil structure; practice contour plowing and minimum tillage to prevent soil erosion	Plant permanent trees along contour line to control erosion and maintain the fertility of the soil
		Cropping Pattern: upland rice -root crops/fruit trees/forest			

Appendices

APPENDIX 1. STEPS TO IDENTIFY SOIL SERIES

Soil sampling

1 Choose a vacant area in your field. Use a spade or soil auger to dig up to 50 centimeters from the soil surface.



2 Depth of the soil is important. The surface/top soil is not a good basis since it is always cultivated.

3 Get a bulk of soil (0.5 kilogram) from 30 to 50-centimeter depth and place it in a container. This sample will be used in soil series identification.

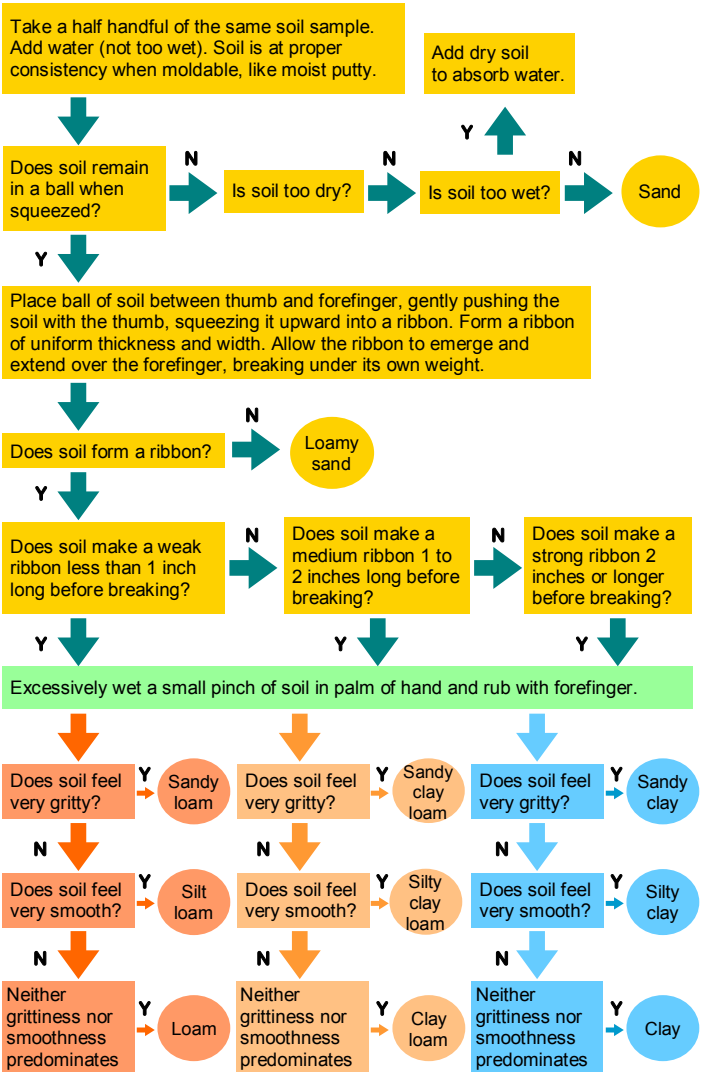
2 Color determination

1 Soil color is an indirect measure of other characteristics such as drainage, aeration, and organic matter content. Black-colored soils may indicate high fertility and productivity. Gray indicates a fairly constant water-saturated condition. Bright brown and red colors are indicative of good aeration and drainage.

2 Get an ample amount of soil from the sample. Note that the soil surface should be freshly exposed and not pressed. Record the moisture condition (dry, wet, or moist). If dry, have a moist color determination by adding ample amount of water to the soil.

3 Compare the color of the soil sample with the color chart in the guidebook. Take note of the classification of the color.

Texture determination



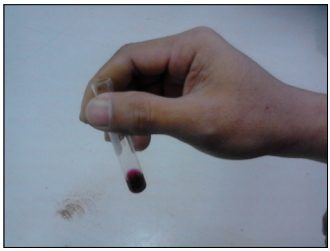
4 pH determination (UPLB) procedure

1 Get soil sample from 30 to 50-centimeter depth. Fill the test tube with soil sample up to the scratch mark.

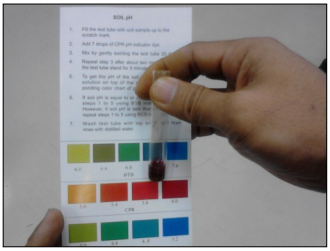
2 Add seven drops of CPR (chloropenol red). Mix by gently swirling the test tube.

3 If pH is six or greater, repeat the steps using BTB (bromthymol blue).

If soil pH is five or less, repeat the steps using BCG (bromcresol green).



4 Match the color of the solution on top of the soil with the corresponding color chart of the pH indicator dye used.



APPENDIX 2. THE PALAYCHECK® SYSTEM

The PalayCheck® System is a rice integrated crop management that combines the technologies and learning processes to identify strengths and weaknesses of current crop management practices, make improvements in the next season to increase grain yield, input-use efficiency, and profit with environmental concerns.

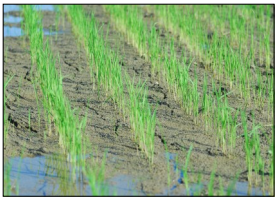
The PalayCheck® System describes the crop management practices (input) to achieve the following Key Checks (output):

1 Used high-quality seeds of a recommended variety.

2 No high and low soil spots after final leveling.

3 Practiced synchronous planting after a fallow period.

4 Sufficient number of healthy seedlings.



5 Sufficient nutrients at tillering to early panicle initiation and flowering.

6 Avoided excessive water or drought stress that could affect the growth and yield of the crop.

7 No significant yield loss due to pests.

8 Cut and threshed the crop at the right time.

Glossary

Base saturation – the amount of positively charged ions (Ca, Mg, K, and Na), excluding hydrogen and aluminum ions, that are absorbed on the surface of soil particles, and measured and reported as a percentage.

Boulder – rocks with grain size of usually no less than 256 mm (10 inches) diameter.

Clay skins – clay coatings on ped or pore surfaces.

Coarse fragments – significant proportions of fragments coarser than very coarse sand and less than 10 inches, if rounded, or 15 inches along the longer axis, if flat. They influence the nutrient status, water movement, use and management of the soil. They also reflect the origin and stage of development of the soil.

Cobblestone – naturally rounded stones larger than a pebble and smaller than a boulder.

Concretions – cemented bodies similar to nodules, except for the presence of visible, concentric layers of material around a point, line, or plane.

Cutans – modification of the soil texture, or soil structure, at natural surfaces (particle, pore, or ped) in soil materials due to illuviation. Cutans are oriented deposits which can be composed of any of the component substances of the soil material.

Gravels – composed of unconsolidated rock fragments that have a general particle size range and include size classes from granule- to boulder-sized fragments.

Inherent fertility – the natural ability of the soil to supply plant nutrients.

Mottles– appearance of uneven spots with spherical or irregular shape. The color differs from the soil matrix color.

Nodules – cemented bodies of various shapes that can be removed as discrete units from soil.

Nutrient retention – referred to as Cation Exchange Capacity (CEC) or the maximum quantity of total cations, of any class, that a soil is capable of holding, at a given pH value, available for exchange with the soil solution.

Pebble – small usually rounded stone especially when worn by the action of water.

Permeability – property of the soil to transmit water and air. It affects irrigation, and leaching of salts and fertilizers.

Quartz – a mineral consisting of silicon dioxide occurring in colorless and transparent or colored hexagonal crystals or in crystalline masses.

Relief – refers to the elevation or inequality of the land surface considered collectively.

Rock – naturally occurring solid aggregates of one or more minerals or mineraloids.

Rooting depth – the ability of the plant's roots to penetrate through the soil. It can be limited by soil compaction, absence of nutrients, waterlogged layer or cemented layers.

Glossary

Salinity – the saltiness or dissolved salt content (such as sodium chloride, magnesium and calcium sulfates, and bicarbonates) in soil.

Slickenside – polished and grooved surface produced by one mass sliding past another.

Soil compaction – described according to its nature, continuity, structure, agent, and degree. Compacted material has a firm or stronger consistence when moist and a close packing of particles.

Soil drainage –refers to the frequency and duration of periods of saturation in the soil.

Soil family – a group of soils within a subgroup having similar physical and chemical properties that affect their responses to management and manipulation for use.

Soil pH –measure of acidity and basicity of soils. It affects availability or release of soil nutrients.

Soil profile – includes the collection of all the genetic horizons, the natural organic layers on the surface, and the parent material or other layers beneath the solum that influence the genesis and behavior of the soil.

Soil series – a group of soils with similar profiles developed from similar parent materials under comparable climatic and vegetational conditions.

Soil taxonomy – hierarchies of classes that permit one to understand the relationships between soils and also between soils and the factors responsible for their character. A systematic distinguishing, ordering, and naming of type groups within a subject field.

Soil texture- refers to the relative proportions of the various size groups of individual soil grains in a mass of soil. Specifically, it refers to the proportions of clay, silt, and sand below 2 millimeters in diameter.

Soil type – the lowest category in classification systems. It is distinguished within series on the basis of texture, a single characteristic.

Soil water retention – the ability of soil to retain water to provide an ongoing supply of water to plants between periods of replenishment (infiltration) to allow their continued growth and survival.

Stoniness – the relative proportion of stones over 10 inches in diameter or on the soil.

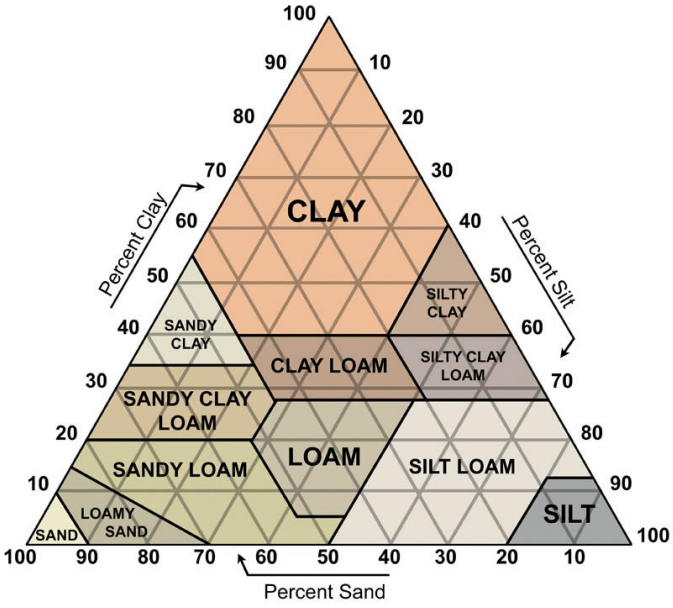
Surface cracking – develops in shrink–swell clay-rich soils after they dry out. The width (average, or average width and maximum width) of the cracks at the surface is indicated in centimeters. The average distance between cracks may also be indicated in centimeters.

Tuff – a rock composed of the finer kinds of volcanic detritus usually fused together by heat.

Workability/tilth – the ease of cultivating the soil with regard to its structure, texture, presence of coarse fragments, and relief.

Soil textural classes

Sand (S) - gritty
Silt (Si) - smooth and floury
Clay (C) - sticky
Loam (L) - equal proportion of S, Si and C
Sandy loam (SL) - presence of S, Si and C; but grittiness predominates
Loamy sand (LS) - distinctively gritty with slight smoothness and stickiness
Silt loam (SiL) - presence of S, Si and C; but smoothness predominates
Clay loam (CL) - presence of S, Si and C; but stickiness predominates
Sandy clay loam (SCL) - presence of S, Si, and C; but more sticky and gritty feel
Silty clay loam (SiCL) - presence of S, Si and C; but more of sticky and floury feel
Sandy clay (SC) - sticky with slight grittiness
Silty clay (SiC) - sticky with slight smoothness



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