Production Optimization of Small – Sized Sugarcane Farms in the Philippines through Optimal Variety Mix using Compromise Programming

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Abstract

Sugarcane is a major Philippine crop. It is also accounted for the 2nd biggest farm area under food crops. Despite the large plantation area, there is a decreasing trend of production of sugarcane in the past few years, both in quantity and quality. One of the reasons is the accumulated decreased productivity of small – sized farm. To address the decrease in sugarcane production, this research aims to (1) provide combination of the best Philippine sugarcane varieties using compromise programming. Flowering, millable stalks, yield potential (LKg/Ha), and reaction to diseases such as downy mildew, smut, yellow spot, and leaf scorch were used as criteria, and (2) recommend cultivation practices based on the chosen varieties to produce more high yield sugarcane for small – size farm in the Philippines. The results show that the five best sugarcane varieties for the current conditions stated are Phil 93-1601, Phil 94-0913, Phil 92-0577, Phil 92-0051, and Phil 99-1793. The best combination of sugarcane varieties and cultivation practices are also listed.

Keywords
Compromise programming, Optimize, Productivity, Sugarcane, Quality

1. Introduction

Sugarcane is a perennial plant that grows well in tropical and in subtropical climate (Department of Agriculture, Forestry, and Fisheries, 2012). It undergoes different processes to produce sugar, molasses, and fertilizer. In the Philippines, sugarcane accounted for the 2nd biggest farms under food crops (Quilang, 2011). The plantation area of sugarcane in the CY 2014 – 2015 and CY 2015 – 2016 decreased from 423, 333 hectares to 416,893 hectares and 413, 264 hectares respectively. Meanwhile, in the CY 2016 – 2017, there is an increase in the plantation area to 421, 358 hectares. However, in the recent statistics of Philippine Statistics Authority (PSA) (2018) on the Performance of Philippine Agriculture from January – March 2018, the gross earnings from sugarcane declines by 21.77% due to drop volume of production by 11.56% and lower price by 11.55%.

The sizes of Philippine sugarcane farms show a large portion of small- sized farms or farms with plantation area below five hectares (Sugar Regulatory Administration, n.d.). This has led to the accumulated decreased production of sugarcane (Sy, n.d.). In order to increase the production of sugarcane in the Philippines, the researchers aim to provide a combination of best Philippine sugarcane varieties and recommend cultivation practices on growth stages of sugarcane for small- sized sugarcane farms.

2. Review of Related Literature and Studies

There are requirements to consider for sugarcane to grow well such as temperature, water, rainfall, soil, timing of the planting, row spacing, depth of planting, and fertilizer. Sugarcane grows best in warm, sunny, frost-free weather areas. It requires a minimum of 600 mm of annual moisture and temperature ranges from 20° to 35° C. Optimum temperature for germination of stem cuttings is 32° to 38° C. Sugarcane responds to a long period of sunlight of about 12 to 14 hours. High humidity (90% to 85%) favors rapid cane elongation during the main growth period. The soil should be kept loose, and thoroughly moisture during planting and watered afterwards till the plants have attained their full height. Rainfall or access to irrigation between 1100 and 1500 mm is adequate provided the distribution is right (Department of Agriculture, Forestry, and Fisheries, 2014). Sugarcane grows on almost all classes of soils ranging from sandy soils to clay loams and heavy clays (Sugarcanecrops.com, n.d.).

The ideal time to plant sugarcane is November (Sugar Regulatory Administration, n.d.). Row and plant spacing for manual planting is 1.0 – 1.3 m x 0.5 m. On the other hand, for normal operations, the best row spacing is between 1.4 and 1.6 m. The setts are planted laid horizontally in a furrow with a depth of approximately 100 mm deep and thereafter are covered lightly with soil. Covering of the soil is best done by hand and compressed by foot to eliminate excess air pockets. Additionally, planting with water at one liter per meter before covering is very effective in improving germination in dry soils (Department of Agriculture, Forestry, and Fisheries, 2014).

Cultivation Practices	Growth Stages of Sugarcane											
	Germination			Tillering			Stalk Elongation			Ripening		
Weed Control												
Cultivation												
Replanting												
Fertilization												
Pest & Disease Control												
Irrigation												
Harvesting												
Months After Planting (MAP)	1	2	3	4	5	6	7	8	9	10	11	12

Figure 1. Timeline of Growth Stages of Sugarcane and its Cultivation Practices (Sugar Regulatory Administration)

The Figure 1 shows the duration of the cultivation practices of every growth stages of sugarcane. Based on personal communication from one of the Sugar Regulatory Administration employee (2018), there are four growth stages of sugarcane: (1) Germination, (2) Tillering, (3) Stalk Elongation, and (4) Ripening. Meanwhile, there are seven cultivation practices in planting sugarcane: (1) Weed Control, (2) Cultivation, (3) Replanting, (4) Fertilization, (5) Pest Control, (6) Irrigation, (6) Harvesting.

Germination phase is the stage from planting up to completion of germination of buds. Tillering phase is the stage of shoots that grow after the initial parent. Stalk elongation phase is the stage wherein the actual cane formation thus yields build up takes place. Ripening phase where sugar synthesis and rapid accumulation of sugar takes place.

Weed control is a cultivation practice wherein farmers attempt to control the growth of unwanted weeds. Cultivation is a cultivation practice wherein farmers preparing the soil and taking care of the sugarcane. Replanting is the act of setting the sugarcane into the soil. Fertilization is the process of testing and applying the needed nutrients of the soil. Pest & disease control is a cultivation practice wherein farmers attempt to control the pest, and disease applying pesticides, and sanitation techniques. Irrigation is the supply of water to sugarcane. Harvesting is the act of gathering ripe sugarcane.

Sugarcane farms in the Philippines encountered diseases than pests. The common diseases include downy mildew, smut, yellow spot, and leaf scorch. Downy mildew is a diseases caused by several oomycete species in the Peronosceloscopora genus, including P. sacchari and P. philippinensis. There are two easily identifiable symptoms of downy mildew: leaf streaks and leaf shredding (Sugar Research Austrailia, 2013). Meanwhile, Smut is one of the most serious diseases of sugarcane. The disease is caused by a fungus, Ustilago scitaminea. The fungus infects plants through buds on standing stalks or germinating buds in the soil. The fungus grows in the plant in close association with the growing points or meristems. Sugarcane smut is easily identified by the black whip-like structure that forms from the growing point of the sugarcane plant. Infected plants are usually stunted and individual stalks are thin with a grass-like appearance (Sugar Research Australia, 2013). On the other hand, Yellow spot is a disease of the wet tropics, being favored by warm, wet conditions. Yellow spot is caused by the fungus Mycovellosiella koepkei. Spores are produced from fungal growth on the underside of the affected leaf which gives a fluffy appearance. Yellow spot causes a yellow lesion on the leaf blade. Lesions are irregular in shape and vary in color and size depending on the sugarcane variety (Sugar Research Australia, 2013). And, Leaf scorch is caused by fungi, Stagonospora sacchari. The initial lesions of the disease on the leaves are very small, red or reddish-brown spot. These tiny spots gradually elongate, assuming a spindle shape with a definite yellow halo (Bureau of Agricultural Research, 2012).

Table 1. List of Philippine Sugarcane Varieties and its some Characteristics (Sugar Regulatory Administration)

Variety	Growth Habit			Flowering	Yield Potential	Reaction to disease			
PHIL 99-1793					2.12 LKg/TC; 170.69 TC/Ha	4	4	5	4
PHIL 97-2041					2.36 LKg/TC; 137.49 TC/Ha	2	1	6	7
PHIL 97-1123					2.39 LKg/TC; 116.31 TC/Ha	2	1	6	7
PHIL 97-0693					2.39 LKg/TC; 122.50 TC/Ha	2	1	6	7
PHIL 94-0913					2.45 LKg/TC; 141.16 TC/Ha	1	2	3	3
PHIL 92-3849					2.17 LKg/TC; 97.07 TC/Ha	4	4	3	3
PHIL 93-3727					2.33 LKg/TC; 112.62 TC/Ha	4	4	5	4
PHIL 93-3155					2.38 LKg/TC; 112.13 TC/Ha	4	4	4	3
PHIL 93-2349					2.28 LKg/TC; 127.67 TC/Ha.	4	4	5	5
PHIL 93-1601					2.34 LKg/TC; 169.13 TC/Ha.	4	4	3	3
PHIL 92-0751				30%	1.91 Lkg/TC; 177.60 TC/Ha; 321.63 Lkg/Ha	4	4	4	4
PHIL 92-0577					2.05LKg/TC; 179.13 TC/Ha; 368.56Lkg/Ha	4	4	3	4
PHIL 92-0051					1.88LKg/TC; 168.59 TC/Ha; 293.01 Lkg/Ha	4	4	4	4
PHIL 91 - 1091				.	2.36 Lkg/TC; 145.18 TC/Ha; 218.31 Lkg/Ha	4	4	5	4
PHIL 90-0345			.		110.28 TC/Ha; 218.00 Lkg/Ha; 1.99 Lkg/TC	4	4	5	4

Good Germinator
Fast Grower
Erect to Recumbent
Very Fast Grower
Erect
Recumbent to lodging

No Flowering Observed
Profuse
Very Sparse
Sparse
Sparse to Non - flowering
Shy Type

DOWNY MILDEW
1 Very Highly Resistant
2 Highly Resistant
3 Intermediate / Moderate Resistant
4 Resistant
5 Susceptible
6 Intermediate Average
7 Highly Susceptible

SMUT
1 Very Highly Resistant
2 Highly Resistant
3 Intermediate / Moderate Resistant
4 Resistant
5 Susceptible
6 Intermediate Average
7 Highly Susceptible

YELLOW SPOT
1 Very Highly Resistant
2 Highly Resistant
3 Intermediate / Moderate Resistant
4 Resistant
5 Susceptible
6 Intermediate Average
7 Highly Susceptible

LEAF SCORCH
1 Very Highly Resistant
2 Highly Resistant
3 Intermediate / Moderate Resistant
4 Resistant
5 Susceptible
6 Intermediate Average
7 Highly Susceptible

The Table 1 shows the list of Philippine Sugarcane Varieties and its some characteristics such as growth habit, flowering, yield potential, and reaction to the disease in downy mildew, smut, yellow spot, and leaf scorch.

Variety Programming refers to the planting of different sugarcane varieties with different characteristics to enable varieties to be harvested in the early and late milling periods. This is essential in order for a variety to express its maximum yield potential (Sugar Regulatory Administration Research and Development, 1991). In order to choose the

best sugarcane varieties, compromise programming will be use. Compromise Programming is a multi – criteria decision making tool that aims to obtain a solution that is as close as possible to some solution in terms of distance (Ringuest, 1992). The distance measure used in Compromise Programming is the family of L_p metrics and expressed as

$$L_p(a) = \left[\sum_{j=1}^{J} w_j^p \left|f_j^* - f_j(a)\right|^p\right]^{\frac{1}{p}}$$

Equation 1

Normalizing between the range [0,1], Equation 1 becomes,

$$L_p(a) = \left[\sum_{j=1}^{J} w_j^p \left|\frac{f_j^* - f_j(a)}{M_j - m_j}\right|^p\right]^{\frac{1}{p}}$$

Equation 2

where $L_p(a) = L_p$ metric for alternative a, $f_j(a)$ = value of criterion j for alternative a, M_j = maximum value of criterion j in set N, m_j = minimum value of criterion j, w_j = weight assigned to the criterion j, p = parameter / balancing factor reflecting to the attitude of the decision maker with respect to compensation between deviations. For $p = 1$, all deviations from f_j^* are taken into account in direct proportion to their magnitudes. For $p = \infty$, the largest deviation is the only one taken into account corresponding to zero compensation between deviations (Kumar, n.d.). Equation 2 will be used per criteria, and then get the summation for every alternative. The sum of alternative will then be the deciding point to which among the alternatives should be chosen, and it is the value which has the lowest value among alternatives.

3. Methodology

In order to perceive the problem regarding the sugarcane farms, a visit was conducted in one of the sugarcane farms in the Philippines. In the same manner, enough related information and data by means of personal communication with the employee of sugarcane farm, reviews of related literatures and studies were gathered. Then, the researchers deliberate for the multi- criteria decision making tool - Compromise Programming. Next, the tool chosen will be applied on the gathered data. Afterwards, choose top five best sugarcane varieties and make combinations. Finally, recommend cultivation practices based on the chosen sugarcane varieties.

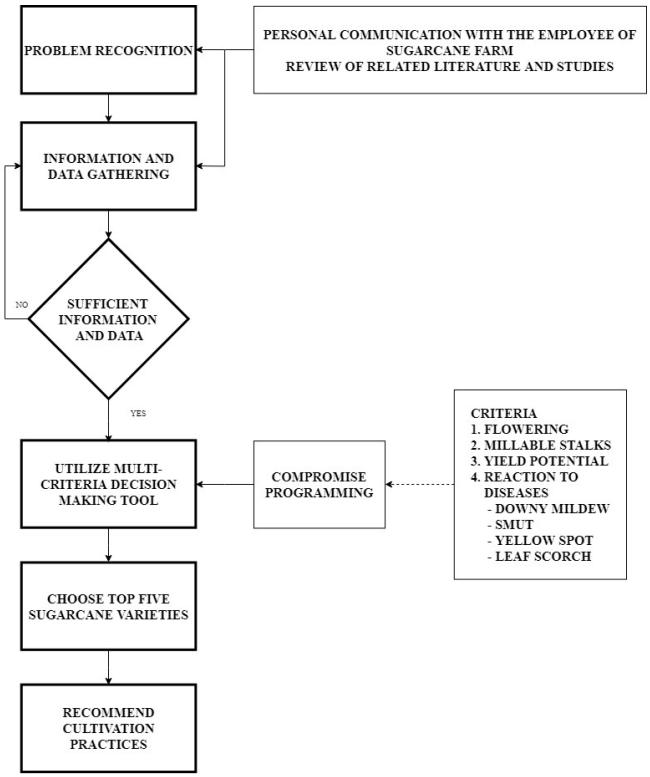

Figure 2. Methodology

4. Data and Results

4.1 Criteria and Summary of Data

Before the utilization of the chosen multi- criteria decision making tool – Compromise Programming, the identification of criteria, data type, and parameters required are important. In the same manner, the data involved in each criterion and alternative must be provided.

Table 2. Criteria

CRITERIA	DATA TYPE	REMARKS / UNITS	PARAMETERS REQUIRED
Flowering	Categorical	1 = Non – flowering 2 = Flowering	MIN
Millable Stalks	Numerical	Number of Stalks	MAX
Yield Potential	Numerical	Lkg/Ha	MAX
Downy Mildew	Categorical	1 = Very Highly Resistant 2 = Highly Resistant 3 = Intermediate / Moderate Resistant 4= Resistant 5 = Susceptible 6 = Intermediate Average 7= Highly Susceptible	MIN
Smut	Categorical	-do-	MIN
Yellow Spot	Categorical	-do-	MIN
Leaf Scorch	Categorical	-do-	MIN

The Table 2 shows the criteria to be considered in optimizing the production of sugarcane. The researchers quantify these criteria as categorical and numerical, also whether maximum or minimum. The rating of the remarks was designated by the researchers based on the given description of the gathered data.

Table 3. Summary of Data

Variety	Flowering	Millable Stalks	Yield Potential	Downy Mildew	Smut	Yellow Spot	Leaf Scorch
Phil 93-1601	1	4	395.7642	4	4	3	3
Phil 94-0913	2	2.48	345.842	1	2	3	3
Phil 92-0577	1	2.49	368.56	4	4	3	4
Phil 92-0051	1	3.06	293.01	4	4	4	4
Phil 99-1793	1	2.37	361.8628	4	4	5	4
Phil 97-2041	2	2.54	324.4764	2	1	6	7
Phil 92-0751	2	2.62	321.63	4	4	4	4
Phil 97-0693	2	2.18	292.775	2	1	6	7
Phil 92-3849	2	2.38	210.6419	4	4	3	3
Phil 97-1123	2	2.14	277.9809	2	1	6	7
Phil 93-3155	2	2.08	266.8694	4	4	4	3
Phil 93-2349	2	2.7	291.0876	4	4	5	5
Phil 93-3727	2	2.39	262.4046	4	4	5	4
Phil 91-1091	2	2.7	218.31	4	4	5	4
Phil 90-0345	2	1.87	218	4	4	5	4
	MIN	MAX	MAX	MIN	MIN	MIN	MIN

The Table 3 shows the summary of data that will be used for compromise programming. It includes the different varieties with the criteria such as flowering, millable stalks, yield potential, downy mildew, smut, yellow spot, and leaf scorch.

4.2 Results

Table 4. Compromise Programming Results

Variety	Score
Phil 93-1601	**0.2857143**
Phil 94-0913	**0.3309457**
Phil 92-0577	**0.4436961**
Phil 92-0051	**0.511387**
Phil 99-1793	**0.5521507**
Phil 97-2041	0.6291235
Phil 92-0751	0.6616688
Phil 97-0693	0.677732
Phil 92-3849	0.6800805
Phil 97-1123	0.6918312
Phil 93-3155	0.70443
Phil 93-2349	0.7632059
Phil 93-3727	0.7704174
Phil 91-1091	0.7836534
Phil 90-0345	0.8395599

The Table 4 shows the compromise programming results sorted from lowest to highest. The top five sugarcane varieties are Phil 93-1601, Phil 94-0913, Phil 92-0577, Phil 92-0051, and Phil 99-1793.

4.3 Combinations

Table 5. Top Five Best Sugarcane Variety

Variety	Yield Potential (Lkg/Ha)
Phil 93-1601	395.7642
Phil 94-0913	345.842
Phil 92-0577	368.56
Phil 92-0051	293.01
Phil 99-1793	361.8628

The table above shows the top five sugarcane varieties with their respective yield potential in Lkg/Ha. In order to choose varieties for two combinations, three combinations, four and five combinations, application of Combination – number of ways picking unordered outcomes from possibilities, must use.

Table 6. Two Sugarcane Varieties Combination

Varieties										
Phil 93-1601	✓	✓	✓	✓						
Phil 94-0913	✓				✓	✓	✓			
Phil 92-0577		✓			✓			✓	✓	
Phil 92-0051			✓			✓		✓		✓
Phil 99-1793				✓			✓		✓	✓
Total (estimated)										
LKg/Ha	370.80	382.16	344.39	378.81	357.20	319.43	353.85	330.79	365.21	327.44

Table 7. Three Sugarcane Varieties Combination

Varieties										
Phil 93-1601	✓	✓	✓	✓	✓	✓				
Phil 94-0913	✓	✓	✓				✓	✓	✓	
Phil 92-0577	✓			✓	✓		✓	✓		✓
Phil 92-0051		✓		✓		✓	✓		✓	✓
Phil 99-1793			✓		✓	✓		✓	✓	✓
Total (estimated)										
LKg/Ha	370.06	344.87	367.82	352.44	375.40	350.21	335.80	358.75	333.57	341.14

Table 8. Four and Five Sugarcane Varieties Combination

Varieties						
Phil 93-1601	✓	✓	✓		✓	✓
Phil 94-0913	✓	✓		✓	✓	✓
Phil 92-0577	✓	✓	✓	✓		✓
Phil 92-0051	✓		✓	✓	✓	✓
Phil 99-1793		✓	✓	✓	✓	✓
Total (estimated)						
LKg/Ha	350.79	368.01	354.80	342.32	349.12	353.01

The three table above shows the total (estimated) LKg/Ha for sugarcane varieties combination. The sugarcane varieties are assumed to be equally distributed in a hectare. The total (estimated) LKg/Ha may vary depends on the distribution of each sugarcane varieties in a hectare.

5. Conclusions and Recommendations

Table 9. Conclusions

Variety	Flowering	Millable Stalks	Yield Potential	Downy Mildew	Smut	Yellow Spot	Leaf Scorch
Phil 93-1601	1	4	395.7642	4	4	3	3
Phil 94-0913	2	2.48	345.842	1	2	3	3
Phil 92-0577	1	2.49	368.56	4	4	3	4
Phil 92-0051	1	3.06	293.01	4	4	4	4
Phil 99-1793	1	2.37	361.8628	4	4	5	4

The table above shows the five (5) best varieties with the lowest score namely: Phil 93-1601, Phil 94-0913, Phil 92-0577, Phil 92-0051, and Phil 99-1793.

It is advisable to have at least two (2) varieties for sugarcane farms greater than 0 but less than 2 hectares. Meanwhile, at least three (3) varieties for sugarcane farms greater than 2 but less than 5 hectares.

The best combination for two sugarcane varieties is Phil 93-1601, and Phil 92-0577 with 382.16 Lkg/Ha. Meanwhile, the best combination for three sugarcane varieties is Phil 93-1601, Phil 92-0577, and Phil 99-1793 with 375.40 Lkg/Ha. On the other hand, the best combination for four/five sugarcane varieties is Phil 93-1601, Phil 94-0913, Phil 92-0577, and Phil 99-1793 with 368.01 Lkg/Ha.

In order to achieve the yield potential of each variety, the cultivation practices from land preparation up to harvesting must be applied. The following recommendations for cultivation practices are from the book entitled “Handbook on Sugarcane Growing Revised Edition 1991” by the Sugar Regulatory Administration Research and Development in the Philippines.

5.1 Land Preparation

Plowing and harrowing are the two most important field operations employed in preparing the field for planting sugarcane. Better soil tilth is obtained when the field is plowed with the right amount of moisture. The field should not be plowed after a heavy downpour. This will result in puddling. To determine if the soil is ready for plowing, get a handful of soil from a depth of 15 – 20 cm and squeeze it in hand. If the soil breaks or shatters easily then the soil is ready for plowing. The field is prepared from November to May as planting coincides with harvesting.

5.2 Seed Piece Selection

The quality of seed pieces used in planting influences the germination and development of the chosen sugarcane variety. Good quality seed pieces are taken from disease free plantation from the vigorous and healthy sugarcane plants like the best varieties abovementioned.

5.2 Planting

In order to take advantage should be done immediately after furrowing – set at 80 -150cm using either a mechanical furrower or animal – drawn plow. Good percentage germination and high cane and sugar yields were obtained at a depth of 10 – 11 inches or 25.4 – 27.94 cm. Additionally, deep planting also improves the growth of the succeeding ratoon crops. Position of planting during dry season, canepoints should be in horizontal position with buds at both sides and covered with 2 inches of pulverized soil. This practice enables the canepoints to take advantage of the available moisture, prevents the canepoints from rapid drying and protects the buds from injury when the rows are pressed either by tractor. Meanwhile, during wet season, the sugarcane points should be planted at a slanting position about 45 degrees with their eyes also on their sides and allowing about 3-5 cm of the canepoints to protrude from the surface of the soil.

5.3 Weed Control

Weed control can be mechanical and manual weed control by using either animal – draw plow or tractor drawn cultivator in the early part of the growing canes usually from 3-4 weeks after planting. If necessary, use manual weed control by pulling up the weed using hand or grab hoes, especially those weeds growing along the rows which cannot be covered by mechanical weed control. In the same manner, weed control can be also done through the use of herbicides in killing or controlling the weeds.

5.4 Fertilizer

There are two kinds of fertilizer that may use: organic, and inorganic fertilizer.

Compost is an example of organic fertilizer. Here are some steps involved in making compost:

1. Gather all compost materials, but eliminate diseased plants. Remove materials that do not decompose like empty cans, plastics, metals, broken glass, etc.
2. Select a well-drained, slightly elevated place near a water source, in an open- air or under a shaded area. Mark the measured compost pile with bamboo stakes.
3. Pile the farm or industrial wastes about 14 cm thick which would serve as absorbent. Rake them smoothly without stepping on the pile, to keep it loose for adequate aeration.
4. Spread a layer of animal manure ab out 3 cm thick over the farm residues. Cover the manure with about 2 cm thick of lime. One to 2 kg of urea or ammonium sulfate and superphosphate maybe added.
5. Repeat steps 3 and 4 until the pile is about 1 to 1-1/2 m high. Place bamboo pole breathers standing with clean nodes and opening on the sides. This will keep the pile fluffy and air will penetrate through the pile.
6. After 3 weeks, remove the bamboo breathers and turn-over the compost pile, building another pile adjacent, and from the original pile. Add water to keep the pile moist.
7. Turn the pile to its original place after 5 weeks and allow to decompose further for 4 weeks more. The compost material is ready for application within at least 3 months.

Meanwhile, inorganic fertilizers also be used. The cheapest combination of fertilizers needed to satisfy the required 140-105-100 kilos per hectare of N, P2O5, and K2O is 4.30 bags of Urea (46-0-0), 4.57 bags of (18-46-0), and 3.33

bags of (0-0-60). In the same manner, utilize fertilizer supplement or substitutes such as rockphosphate, mill wastes, and by-products, and farm wastes to build up soil fertility, and consequently reduce cost. Small- sized farms can choose either of the method depends on their budget.

5.5 Irrigation and Drainage

The total water requirement of sugarcane consists of the water needed by the crop plus the losses associated with the delivery and application of the water. The following table shows the monthly water consumptive use of sugarcane.

Table 9. Monthly Water Consumptive Use of Sugarcane

	Jan	Feb	Mar	Apr	May	Jun
Inches	6.3	4.8	5.3	4.0	5.6	2.9
Millimeters	160	121.9	134.6	101.6	142.2	73.7
	Jul	Aug	Sep	Oct	Nov	Dec
Inches	3.3	2.9	3.5	4.3	5.0	5.1
Millimeters	83.8	73.7	88.9	109.2	127.0	129.5

Scheduling of irrigation involves prediction of both the best time and the right amount of the next succeeding irrigations on each field considering expected rainfall, available water supply and the capacity of the delivery system. On the average, the frequency or interval of irrigation ranges from 10 to 21 days during dry months. There are some types of irrigation system that could be used in farm, furrow irrigation, subsurface irrigation, sprinkler, or overhead irrigation, and drip irrigation. Small- sized farms can prepare furrow irrigation because it is adaptable to a great variety of land slopes and soil textures and can be used with either large of small streams of irrigation water.
Meanwhile, drainage of sugarcane fields is an absolutely necessity because of high rainfall intensity that prevails over the Philippines. Poorly drained areas become “water logged” or oversaturated with water during the rainy season. With properly designed and constructed drainage facilities and networks, excess or “unwanted” water especially during the rainy months is removed from the soil. There are some types of drainage system that could be used in farm such as surface drain, and sub-surface drain.

5.6 Disease Control

In this manner, the five (5) varieties are resistant and very highly resistant to downy mildew. However, when it is occurred, avoid ratooning with infected plant instead plant a new resistant variety. Likewise, for chemical control, soaking seedpieces in Apron 35 SD (35% methyl D L-N 2-6 dimethyl) – N- (2’- methoxyacetyl) – alalinate (Ciba-Geigy metalaxyl) solution at 50 g a.i./200 liter of water for 10 minutes effectively controlled downy mildew.

The five (5) varieties are highly resistant and resitant to smut. However, when it is occurred, avoid ratooning with infected plant and eradication of alternate hosts such as wild-cane or “talahib” and “aguingay”.

On the other hand, the four (4) varieties are intermediate / moderate resistant and resistant to yellow spot and, one (1) variety is susceptible for yellow spot. The only way to control the disease is through sanitation – like burning of trashes and infected stalks.

The five (5) varieties are intermediate / moderate resistant, resistant to leaf scorch. The way to prevent the spread of this disease is to eradicate alternate hosts such as “talahib”, “cogon”, and “aguingay”, and burn heavily infected field after harvest to kill conidia in pycnidia on plant debris and in the soil.

5.7 Harvesting

Harvesting is one of the most critical operations in sugarcane farming. To recover the highest possible sugar from the cane, the crop should be harvested at maturity. However, sugarcane varieties mature at different ages. This variation is due to their varying genetic characters and photo-synthetic efficiency. Hence, sugarcane varieties are classified as early maturing, medium or late maturing. Also some varieties retain good cane quality even if harvested beyond minimum age. There are two methods of harvesting sugarcane: by manual operation using cane knife or machete and by machine.

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