CHAPTER 4
STUDY ON REPRODUCTIVE CHARACTERISTICS OF JATROPHA

Introduction

Poor harvesting has been the major retarding factor for commercialization of this crop and this has been highlighted in many publications (ERIA 2010; Biswas et al. 2006 and Heller 1996). Mechanical harvesting of this crop was considered impossible due to this indeterminate flowering and growth habit. Today, jatropha fruits are still harvested by hand in small and plantation scale farms. The phenophases in plants depends on the interaction between various phytohormones with the environment (Bruns 2009). Time of harvesting after anthesis of this crop can vary from as early as 37 days (Annarao et al. 2008) to 90 days (Heller 1996). Contrary recommendations on harvesting time, based on days after anthesis, was also thought to be due to this indeterminate growth habit of the crop but little information exists on these characteristics.

Long term solutions of the poor harvesting problem could be by breeding of varieties whose growth habits are determinate with uniform fruit maturity. These traits can make harvest scheduling possible for maximum economic yield. Unfortunately, the breeding of new varieties is costly and time consuming and, therefore, near-term solutions are also needed during domestication of local accession. One of the solutions involves harvest and postharvest treatments. Since the poor harvesting efficiency has been attributed to the reproductive growth habit, thus main objective of this study is to focus on characterizing the habit. This involved monitoring the lifecycle duration, measurement of the number of active and non-active branches, number of inflorescence, measurement of fruit maturity uniformity on the tree and measurement of fruit size development.
Materials and Methods

Test samples for study on fruit maturity uniformity of different jatropha accessions

To obtain information on the maturity uniformity characteristics of different jatropha accessions, data on ten selected accessions at two jatropha pilot projects in Sabah, Malaysia was collected. The pilot projects are the jatropha pilot project belonging to the Sabah Department of Agriculture at Tenom Research Station and the jatropha pilot project belong to the Sabah Land Development Board at Binakan, Sook, Keningau, Sabah, Malaysia. Both pilot projects started first planting in March 2008. The data was collected at the end of March, 2009 when the trees were exactly a year old. In this survey, only five trees per accession were randomly selected for data collection because technically, counting the number of total fruits based on maturity stage was exceedingly time consuming.

Test sample for study on fruit maturity uniformity at harvest

The test sample for this study was from seven selected accessions out of ten from the two pilot projects described above. During a study visit to the site in March, 2009, the officer in charge of the project was requested to harvest five bunches per accession. The fruit bunch character used by them was bunches that have more ripe yellow fruits.

Test samples for study on reproductive characteristics throughout the year

The test sample for this study was from the main source sample in this study as described in Chapter 3. Ten jatropha trees were randomly selected in the pilot project and the variables were measured every month at week three from January to December 2010. The reproductive characteristics observed were the active and non-active branches, number of inflorescence, number of buds, number of fruits and
percentage of maturity. The rainfall data for 2010 was collected from the Metrology Department of Malaysia for correlation study.

*Test samples for study on reproductive lifecycle duration*

The test sample for this study was from the main sample source in this study, as described in Chapter 3. To start determining the lifecycle duration, the date of planting was recorded (July 16, 2009). For determination of bud development, flowering, fruit maturation, ripening and senescence duration, 30 trees were randomly tagged in the plot. Following this, the inflorescence on each tree, which normally emanates from the main stem, was tagged. The changes in the reproductive variables, from inflorescence to fruiting, and sequence of fruit development and maturation, were recorded daily. Fruit maturity stages were predetermined as described at Chapter 3.

*Test samples for study on fruits’ size during growth and development on the tree*

The test sample for this study was from the main sample source in this study as stated earlier. The girth, length and thickness size of fruit during maturation, ripening and senescence were measured every day from the day after fruit bloom (DAFB) until the fruit was ripe and senescence. Two conditions on the measurements on the size we made. First was measurement of dominant fruit per bunches from a randomly selected bunches per trees. Fruits grow at the tip of the bunch and naturally the dominant fruits were selected for this first measurement. Second was measurement of each individual fruits per bunches from randomly selected three bunches per trees
Measurement of total active and non-active branches

An active branch is a branch that has any of the reproductive variables such as fruit and inflorescence. The non-active branch refers to absence of reproductive variables. Both variables were measured for each of the randomly selected trees.

Measurement of fruit maturity uniformity

Measurement of fruit maturity uniformity was according to the methods described in the Chapter 3.

Measurement of total inflorescence

The number of flowers and/or buds per tree was measured by simply counting the variables on each of the randomly selected trees.

Measurement of fruit size

The size of the selected individual fruits and all the fruits in similar bunches, during growth and development, were measured according to the methods described in Chapter 3.

Experimental design and statistical analysis

The Experimental design for all five studies in this chapter has been indicated in the explanation of each test sample. Experimental design for study on fruit maturity uniformity from different jatropha accessions is non-experimental quantitative research type with variables identified but not manipulated. Five trees for each of seven selected accessions were identified for the study on heterogeneity of fruit ripening on the tree (n=50), while five bunches from seven selected accessions (n=35) were identified for study on heterogeneity of fruit ripening on the bunch. The
collected data were analysed descriptively which means values were obtained, summarized and described. Experimental design for the study on reproductive characteristics throughout the year was a completely randomized design (CRD) with the month as a fixed identified variable and replicated ten times. Experimental design for the study on fruit size during growth and development was a CRD with different trees and bunches as fixed identified variables, replicated eight times for trees and ten times for bunches. The data collected from CRD was analysed using one way ANOVA. The differences between means were calculated from the error bar at 5%.

Fruit maturity uniformity in whole tree from different jatropha accessions

Variability of fruit maturity in the whole tree for ten selected jatropha accessions was determined. The results showed that all accessions have high fruit maturity variability (Figure 1). On average, 50% of the fruits at ripening index one were expected because this stage also includes the immature fruits or young fruits. Appendix 15 showed the fruit maturity of multiple bunches in single branch of jatropha.

The Minimum, maximum and average were summarized and described. Data collected from CRD was analysed descriptively. The Minimum, maximum and average were summarized and described.

Results and Discussion
Figure 2. Percentage of fruits according to maturity index of selected *J. curcas* L. accessions trees at Sabah, Malaysia in March 2009. Different legends indicate the different accessions and the solid line indicates the average percentage of fruits according to maturity per tree.

The results of this study are in agreement with previous studies in that ripening of jatropha fruits on the tree is not uniform (Biswas *et al.* 2006 and Heller 1996). A high negative polynomial relationship ($R^2=0.73$) between the percentage of fruits at maturity stage in this study demonstrated the level of ripening heterogeneity occurrence in this crop (Figure 2). The method used to explain fruit maturity, ripening and senescence heterogeneity in this study showed an alternative method to measure these occurrences. The importance of the maturity stage in post-harvest handling of many horticultural produce has been well known for many years. Ripening index standards have been developed in many countries as national standards. International ripening index standards for many horticultural produce are also available and can be found in the CODEX alimentarius.

As mentioned earlier, concern over the problems of ripening heterogeneous in this crop is unquestionable when it is related to harvesting problems. Long term
solutions could be by controlling all factors related to the problem such as genetic characteristics (Ginwal et al. 2005), site characteristics such as rainfall, soil type and soil fertility (Francis et al. 2005; Openshaw 2000 and Aker 1997), plant age (Heller 1996) and management (Heller 1996 and Sharma et al. 1997). According to Bruns (2009) the phenophases in plants depends on the interaction between various phytohormones with the environment. Thus future understanding on the reproductive characteristics implied could provide an alternative to reduce the present problem of lower harvesting volume per visit and difficulty in harvesting schedule.

**Fruit maturity uniformity in bunches of selected jatropha accessions**

Fruit maturity uniformity in harvested fruit bunches from selected jatropha accessions was determined because some reports in literature recommend harvesting of bunches instead of individual fruits. The results of this study showed that irrespective of accession, fruit ripening was not uniform in any single harvested bunch. A high fruits ripening percentage was observed at maturity stage five or fully yellow fruits of around 25%, while lower percentages were observed at both maturity stage one and nine, with values of only 1% and 3% respectively (Figure 3). Appendix 16 showed the appearance of fruit maturity uniformity per bunch in photos. The relationship between percentage of fruits and maturity stage is best described by the positive polynomial model with a high correlation of about 80%. Variability of fruit maturity in this study showed that this problem is a natural phenomenon in this crop. Therefore, this study corroborates many previous reports that variability in fruit maturity in this crop was not only within the whole tree but also within individual fruits in bunches.
If this natural phenomenon is taken into account in the argument relating to harvesting recommendations, it is believed that more information is required to come up with practical harvesting and post-harvest handling recommendations. Our interest in the harvesting recommendation of bunches relates to unripe and over ripe fruits. Unripe fruits might require sorting and postharvest ripening treatments. However no such treatment is available in current literature on jatropha. In addition, which maturity stage will result in high quantity and quality of crude jatropha oil for biofuel feedstock is still not clear. It is also important to note that there are physiological and biochemical differences between fruits attached to and off the tree. According to Wills et al. (1989) the development and maturation of fruits is completed only when it is attached to the plant, but ripening and senescence may proceed on or off the plant. Therefore, this study opens up many future research possibilities in the area of post-harvest physiology.
Fruit maturity uniformity throughout the year 2010

The trend of maturity uniformity was monitored throughout the year. The results showed that immature young and dry fruits were dominant throughout the year (Figure 4). Percentage of immature fruits, which indicated the amount of new fruits, showed the three highest and lowers points throughout the year. January, middle of May and June and November were the high points while March, August and December was the lowest points. The production trend of new fruits was in direct contrast to the amount of dry fruits. The point of highest number of new fruits was also the point of lowest number of dry fruits. The other maturity indexes were also seen to be available throughout the year but at lower percentages of not more than 20%.

Figure 4 Trend of fruit maturity uniformity of *J. curcas* L. Luanti accession throughout the year 2010.
The results of this study showed that the fruit maturity uniformity of jatropha appeared throughout the year. This indicates a problem with harvesting due to this variability and requires a solution during domestication of local accession. Based on information that high oil content was found in the dry fruit (Heller 1996; Wiesenhutter 2003; Nurcholis and Sumarsih 2007; Priyanto 2007 and Hambali 2007) and based on the results of this study, the trend of high percentage of dry fruits could be the reason for previous researchers recommending it as a harvesting indicator. However, this recommendation implies high harvesting costs because harvesting individual fruits can lead to frequent harvesting visits being required. Thus, future study is recommended to confirm this recommendation.

The three highest numbers of fruits in this study was in agreement with a previous report by Careles (2009) on this crop. The researcher suggested harvesting at the peak period. The results of this study are not in agreement with the researcher’s recommendations. Obviously, there were two types of three production peaks in this study. Both immature and dry fruits showed three peaks in production throughout the year of observation. This implied that the researcher should refer the recommendation to any one of the fruit groups. This study also implied occurrence of fruit fall with delay in harvesting. Decrease in the number of dry fruits after reaching the peak was implied due to fruit fall. Thus, future study should be conducted to identify the effect of delay in harvesting on the loss of fruits due to fall fruits.

Variation of total active and non-active branches

The characteristics of active and non-active branches were monitored throughout the year. Irrespective of branch characteristics, the variation on the number per tree was significantly high. Almost each of the observed samples was significantly different from each other throughout the months of observation (Figure 5). In general, the number of non-active branches increased with advancing age of crop. The average number of non-active branches was less than 10 branches per tree in January but increased to about 30 per tree in October 2010. Slight increase in the
The number of active branches from early in the year to the end of the year of observation was recorded. Significant increase in the number was seen from April to May from only about five active branches in April to about 20 in May. Fluctuation in the number of active branches from April to May was probably due to the changes in rainfall. The Dry season in the area was in February, while rainfall was available in March and April but decreased slightly in May 2010 (Appendix 12).

Figure 5 Characteristics of *J. curcas* Linn Luanti accession active and non-active branches throughout the year 2010. Different legends indicate replication of data and the solid line indicates the average number of branches per tree from the ten observed trees.
An active branch refers to branches that has either/or fruits bunches inforescence and buds. To this extent, increase in number of branches in this study did not indicate an increase in fruit production. Obviously, total numbers of branches have always been used as a common variable to determine yield of this crop (Appendix 3). Results of this study were in agreement with Raden (2008) that not all branches are productive or producing bud, inforescence or fruit. The production prediction should ensure that only active branches are to be counted in the prediction.

Agronomic practices related to management of these branches are water sprout management and pruning. Available data in this study suggest that water sprouts should be removed regularly in the jatropha farm and the objective of pruning is not to increase the number of new branches but to make harvesting more easily. Pruning is reported to lead to delay in flowering and fruiting in jatropha (Carels 2009).

**Variation in production of inflorescence**

Figure 6 shows the production trends of inflorescence throughout the year 2010 or *Jatropha curcas* Linn Luanti accession. The variability in number was considerably high throughout the month of observation. The data showed that the minimum and maximum inflorescence production in May 2010 was about 10 and 40 respectively. The phenophase development in this study was seen to be affected by the agro-climate. Stress on the plant during the dry season in February followed by increase in rainfall in the following month resulted in a burst of inflorescence (Appendix 12). The number decreased when there was a sudden decrease in rainfall in August but increased again when the rainfall increased in the following month (Figure 6).

This relationship between the weather and the data in this study could indicate that dry seasons resulted in water deficit which increased the number of flowers and small fruits abortion. Flowering is generally considered to be advanced by water deficits in many woody perennial species. Mwanamwenge *et al.* (1999) reported a significant abortion on faba bean flowers and small pods due to water deficit. This
study contradicts the Mwanamwenge et al. (1999) report. Sharp et al. (2009) demonstrated that in *Rhododendron* flowering is promoted with water deficit treatments. Early drop of flowers is a normal process in many species (Guitián 1993). The reasons are unclear, but low flower bud drop is related to improved fruit set (Jackson and Hamer 1980). Fruits from cross-pollinated flowers in the crop was reported to be significantly larger, heavier and more numerous than those produced by autogamous self-pollinated flowers. Therefore, it is not surprising that honeybees play a positive role in jatropha pollination (Abdelgadire et al. 2008).

**Figure 6** Production trends of flower buds of *J. curcas* Linn Luanti accession throughout the year 2010. Different legends indicate replication of data and the solid line indicates the average number of branches per tree from ten observed trees.
Variations in fruit production

Figure 7 shows the fruit production trends throughout the year for the *J. curcas* L. Luanti accession at Keningau, Sabah, Malaysia. The data showed huge variability in any month of observation. The high difference in fruit production per tree was recorded in June and July. Higher and lower fruit production per tree in both months were about 425 and 100 in June and about 400 and 60 in July respectively. The trend of fruit production is seen as similar to the trend in inflorescences production (Figure 6). The high number of inflorescences produced in May resulted in an increase in the number of fruits in June.

![Fruit production trends throughout the year of *J. curcas* Linn Luanti accession. Different legends indicate replication of data (different trees) and the solid line indicates the average number of branches per tree from ten observed trees.](image)
Variability in fruit production is affected by various factors. In this study the weather conditions are implied to influence flowering. According to Burgos et al. (1993) the weather affects pollination, therefore, stigma receptivity, ovule fertility, ovule longevity and fruit set are directly affected. Furthermore the researcher explained that there are many genotype-dependent factors related to floral biology, that influenced fruit set and, consequently, productivity, such as flower bud production, flower bud drop, flowering time, ovule development stage at anthesis, pollen germination, height difference between the stigma and the superior plane of the anthers, aborted pistils and the autogamy level. However, the related variables are not monitored in this study.

Fruit production variability in this study could also indicate the potential of failing in a production prediction for this crop. Various variables are used by many researchers to calculate jatropha fruit production (Appendix 3). In this study minimum and maximum number of fruits can be calculated by multiplying the total fruits per tree with number of jatropha trees per unit area (Figure 7). With 2 x 2 m planting distance, minimum 250,000 and maximum 1,062,500 individual fruits can be harvested in a hectare in May. If each fresh fruit weight is 15 g the production is equivalent to a minimum of 3,750 kg/ha and maximum of 15,938 kg/ha. If the fresh weight of seed per fruit is 3.5 g, the minimum and maximum fresh seed production are 875 kg/ha and 3,719 kg/ha. Thus if fresh seeds contain 30% moisture content, minimum and maximum dry weight in May are 612.5 kg/ha and 2,603.3 kg/ha respectively. Furthermore, if the seed is to be extracted and there is only 25% extraction efficiency with mechanical extraction, the minimum and maximum extracted oil yield will be only 153 kg per ha and 651 kg per ha in May respectively.

The fact with the above calculation is that not all fruits in the trees were ready to be harvested. Previous data in Chapter 4 Figure 4 indicate the variability of fruit maturity and thus the calculation should be revised based on this. The maturity variability indicated only about 50% of the fruits is in dry stage, 20% are in immature stage and the other group of fruits are counted to be around 30%. As dry fruits were the recommended harvested fruit, thus the minimum and maximum harvestable dry
seeds in May was only about 306 and 1,302 kg per ha. The dry seeds are equivalent to minimum and maximum extracted oil yield of about 77 and 325 kg per ha.

The reduction in the total number of fruits per hectare was observed from July to September 2010 (Figure 6). This indicates occurrence of fall fruit during delay in harvesting. There was no harvesting throughout the observation in this study. This indicates that it is important to understand the fall fruits characteristics because it is expected that these factors contribute to loss in biomass and the point of minimum harvesting visits. On the other hand, total loss should be included in the calculation of real harvestable volume of jatropha during specific months of production.

Variations on total bunches per tree and frequency of fruits per bunch

The total number of bunches per tree throughout the year 2010 for jatropha Luang accession planted at Keningau, Sabah, Malaysia showed not uniform (Figure 8). The average production of the bunches per tree showed increase in the first six months from January to June after which there was a decrease in July reaching minimum in September. Slight increase after September was observed until end of the observation period. The trend of total bunches per tree was similar to the trend of total fruits per tree (Figure 7). The frequency of fruits per bunch indicated the function of bunches and the average variability in frequency is presented in Figure 9.

The frequency of total fruits per bunch in this study showed that the highest number of fruits per bunch was five and six followed by nine, eight and seven. Frequency of fruits per bunch of more than 10 was only about 10%. Results of this study were not in agreement with the report by Kumar and Sharma (2008). The researcher reported that each inflorescence yields a bunch of approximately 10 or more void fruits. There are many factors that could affect the frequency of occurrence. Plant growth regulators have been tested by Abdelgadir et al. (2010). The researcher reported a positive effect of 2, 3: 4, 6-di-O-isopropylidene-2-keto-l-gulonic acid with more fruits per bunch and more seeds. However, the researcher identified more fruits per bunch, around five to six fruits per bunch, which was considerably
lower in this study. High number of fruits per bunch should be where a bunch has more than 15 fruits.

Figure 8 Variations in total bunches per tree throughout of the year for *J. curcas* Linn Luanti accession. Different legends indicate different trees and the solid line indicates the average number of branches per tree from 10 observed trees.

Figure 9 Frequency of total fruits per bunch for *J. curcas* Linn Luanti accession. Vertical lines indicate the error bars of measurement at 5%.
Variation in fruit size during growth and development

The changes in the fruit length, thickness and girth size from day after fruit bloom (DAFB) to physiologically mature, ripe and senescence is presented in Figure 10. The data shows variability in size irrespective of the size characters and sources of variance. In general, the trend of the fruit size changes from DAFB to advancing maturation, ripening and senescence were similar, which is best described by polynomial trend lines (Figure 10).

Figure 10 Changes in *J. curcas* L. Luanti accession fruit size (length, thickness and girth) during growth and development from day after fruit bloom to ripe and senescence. Different trees (T) and different individual fruits (F) from similar bunches are the sources of variance. The solid lines indicate the average polynomial with R value and the dashed line indicates the means of the data.
The trend followed normal fruit growth in many crops and can be divided into three sub-phases: an early accelerating phase, a linear phase and a plateau phase for ripening. In this study, the data showed that irrespective of fruit size character, the size of fruits from similar bunches was low compared to fruits from different trees. Average length, thickness and girth size value at 24 DAFB in fruits from similar bunch was about 3.0, 2.5 and 8.5 cm respectively. The average length, thickness and girth size value at 24 DAFB in fruits from different trees was about 3.5, 3.0 and 9.0 cm respectively. Fast fruit length, thickness and girth size changes was observed in the first two weeks after fruit bloom from only about 1.0, 0.6 and 2.5 cm in the first DAFB to about 3.4, 3.0 and 8.5 cm after 12 DAFB respectively.

The variability in size in this study provides information on the possibility to harvest jatropha according to size. However, fruits of similar size might not be of similar maturity stage. The state of fruit maturity is important because it has a different physiological character at different stages and thus requires different postharvest handling. For example ripe and senescence fruit, both recommended as harvesting indicators, will be directly processed for storage or oil extraction. However, harvested mature green fruit might require postharvest handling such as ripening treatment before further handling. Variation in fruit size poses problems in grading harvested fruits and as a consequence additional costs for the operational house to install grading machines or to pay additional labour cost. To make the task more efficient, a grading machine with computerised grader is normally installed, however this installation increases cost. Applying specific harvesting practices at the farm level can be used as an approach to reduce grading cost. This approach is recommended for manual harvesting in apples because variations have been identified (De Silva et al. 2000). Variability in fruit size can be affected by various factors. The yield of Jatropha is controlled by genetic characteristics (Ginwal et al. 2004), site characteristics (rainfall, soil type and soil fertility) (Francis et al. 2005; Openshaw 2000 and Aker (1997), plant age (Heller 1996) and management (Heller 1996; Sharma et al. 1997 and Sing et al. 2006).
Days required for reproductive variables to reach specific stage of development

The results showed that jatropha starts to bear flowers within 93 to 124 days after seeding (Table 1). First buds appear within 85 to 98 days after seeding and will develop to become flowers within 7 to 18 days. Flowering to fruit set occurred within one to eight days. Fruits develop physiologically or reach mature green stage within 21 to 35 days from fruit set. Soon after physiological maturity, the fruits start to ripen or senesce which required 2 to 4 days to become fully yellow or fully ripe fruit and 3 to 9 days to become fully black or fully senesced fruit. The results of this study indicate that the lifecycle of the local Luanti jatropha accession planted at the Agro-Biotechnology plot showed indeterminate growth habits. The fruits’ lifecycle for this accession reached completion within a wide range of days (Table 1).

Table 1 Days required by *J. curcas* L. Luanti accession reproductive variables: growth or changes from seeding, appearance of buds to fruit maturation, ripening and senescence.

<table>
<thead>
<tr>
<th>Reproductive variables</th>
<th>Days</th>
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<tr>
<td></td>
<td>Min.</td>
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<tr>
<td>Seeding to first appearance of bud</td>
<td>85</td>
</tr>
<tr>
<td>Bud development</td>
<td>7</td>
</tr>
<tr>
<td>Flowering to fruit set</td>
<td>1</td>
</tr>
<tr>
<td>Fruit set to mature green fruit</td>
<td>21</td>
</tr>
<tr>
<td>Mature green to yellow fruit</td>
<td>2</td>
</tr>
<tr>
<td>Mature green to black fruit</td>
<td>3</td>
</tr>
<tr>
<td>Mature green to dry fruit</td>
<td>6</td>
</tr>
<tr>
<td>Flower to yellow fruit</td>
<td>24</td>
</tr>
<tr>
<td>Flower to black fruit</td>
<td>27</td>
</tr>
<tr>
<td>Flower to dry fruit</td>
<td>36</td>
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</table>

Variability in first flowering and fruiting in this study are in agreement with the report by Carels (2009). However, the researcher reported that in general the first flowering and fruiting after planting started between 4 and 5 months. Furthermore the researcher stated that this only happened after 7 months and/or lasted till the second year. The plant is pruned to increase production. Pruning is recommended for
building tree architecture (Openshow 2000). These practices implied mechanization of cropping, promote branching as does nitrate (N) fertilization and water.

The results of this study demonstrate difficulty in harvesting scheduling. If dry fruits were recommended as the harvesting indicator then harvesting visits need to be done within 6 to 17 days for the same tree. Furthermore, if a yellow ripe fruit is to be recommended as the harvesting indicator then harvesting visits is required to be done within 2 to 4 days only. The data of this study agrees with the argument of high harvesting costs reported by ERIA (2010), Biswas et al. (2006) and Heller (1996) for this crop due to the requirement for regular harvesting visits.

Today, most of industrial crops are classified as determinate crops. Therefore management of these crops is easier and can be manipulated for maximum economic yield (Bruns 2009). However, realistically crop development and/or its maturation are affected by light, temperature changes and interactions with phytohormones. For example, well known determinate soybeans were reported to be only suitable for specific locations and its determinate habit changes into indeterminate habit if planted in other places (McWilliams et al. 2004). Therefore, efforts to find determinate jatropha accession should be done in the future.

**Conclusion**

All reproductive variables observed in this study had comparably high variability. Days required to reach recommended harvesting index varies, implying that harvesting visits to the same tree is should be done rapidly and in a short duration. Jatropha fruits are available throughout the year but there is high variation between observed trees. As a consequence the jatropha production prediction is difficult. In addition, the crop showed variation in sizes, which is expected to lead to difficulty in grading of harvested fruits for further handling practices. Rainfall was found to have a direct effect on fruit production. After the dry season and start of rain showed increase in the number of inflorescence, however increase in the number of
branches does not affect the number of fruits and/or inflorescence. Thus, recommendation to prune to increase number of new branches is not advisable. The frequency of total fruits per bunch in this study showed a positive relationship with total fruit production. Thus, this finding suggests future study to increase the frequency of more fruits per bunch as an approach to increase fruit production. With the high variation amongst the variables, this study suggests that jatropha should be classified as an indeterminate class of crop. As an indeterminate crop, the harvesting problem needs to be addressed by future studies to identify other important variables of the crop so that more solutions to the problem can be suggested.