Research and Demonstration on Banana production Technologies in Micronesia

Final Report for SW05-053

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Principal Investigator:

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Project Information

Abstract:

Research and demonstration farms were established at the R & D Station and in farmer cooperator’s farms in Ngaremlengui, in Airai and in Melekeok State in Palau using tissue-cultured Lacatan banana to showcase appropriate banana production technologies for successful banana production. The fertilization experiment showed that in all the demonstration areas “Lacatan” banana fertilized with manure and fertilizer every 2 months were significantly taller and gave the highest yield than those fertilized at planting time only or those given manure every 2 months. A Training on Banana Production was conducted and a Manual on Banana Production was published to ensure that information generated from this project was disseminated to farmers in Palau.

Project Objectives:

The project aimed to :

1. Establish research and demonstration areas in producers' farms on traditional and appropriate technologies for small-scale banana production.

2. Set up an experiment in producers' farms to determine nutrient requirements for successful banana production in Palau.

3. Visit of Principal Investigator and Project Cooperator to a commercial banana plantation in Davao City, Philippines, to learn latest trends and technologies in banana production.

4. Assist and guide the farmer in appropriate cultural management practices, post-harvest technology and marketing strategy to ensure successful banana production.

5. Produce a handbook on small-scale banana production

6. Train farmers and extension agents on best management practices for successful banana production.

Introduction:

Banana is the leading fruit produced in the Pacific Islands. It is a well adapted subsistence crop in Micronesia and is usually grown in backyards for family consumption only (Sproat and Migvar, 1966). In Micronesia, it is grown for commercial production in Guam (Scully and Bevacqua, 1990) and Kosrae (Josekutty, 2003). However, in Palau, there is no consolidated area for banana production. Palau's maritime tropical climate is very ideal for banana production. Rainfall is uniformly distributed throughout the year and it is outside the typhoon zone in the Pacific. Considering that Babeldaob Island in Palau is the second largest island in Micronesia, and it is very near Guam, there is a lot of potential for banana production both for local consumption in the domestic market and for export to Guam.

In Palau, tourism is the primary source of revenue. A total of 57,000 tourists visited the country in 2001, 42% coming from Japan, 23% from Taiwan and the rest are from the U.S., Canada, Europe, Australia and other countries (Palau Statistical Yearbook, 2002). These tourists are therefore a very captive market for tropical fruits.

It has been reported that banana is the leading tropical fruit sold in the local market (Del Rosario, 2001). However, there is no steady supply of locally produced fruits to meet the growing demand by Western, Japanese and Chinese tourists coming into the country.

The project addressed the need to increase and ensure adequate supply of fresh tropical fruits for the growing demand of the domestic market and the local tourism industry.

The demonstration areas in farmers' fields showcased and compared traditional and appropriate banana production technologies to obtain high yields of banana. Production of a handbook and a training course on banana production ensured information dissemination of technologies demonstrated in the project. This also encouraged farmers to plant and grow bananas for the local market, thereby increasing their income and improving the farmer's quality of life.

Research

Materials and methods:

A visit to commercial banana plantations in the Philippines was done to observe the latest trends and pick the latest technologies for banana production that are applicable in Palau.

Samples of soils from the farmer cooperators were brought to an appropriate laboratory for soil analysis in January 2006 to determine the native nutritional status of the soil. In February 2006, 500 tissue-cultured "Lacatan" banana meriplants were obtained from a commercial tissue culture laboratory in Davao, Philippines, to have adequate uniform planting materials for use in the experiments. Furthermore, the use of tissue cultured planting materials ensures uniform development and harvesting (Josekutty, 2003). They were established and acclimatized in the greenhouse until they have reached the appropriate size for field planting.

To determine the nutritional requirements for the optimum growth and development of "Lacatan" banana on Palau, each demonstration farm was divided into four sections, with the following treatments: a) no manure and fertilizer (Control); b)

manure and fertilizer at planting time; c) manure and fertilizer every 2 months; and d) manure every 2 months. Chicken manure was applied at 2 kg/mat and complete fertilizer was applied at 500 g./ mat.

Tissue-cultured “Lacatan” banana planting materials were planted in each of the demonstration farms in a randomized complete block design. The plants were laid out at 4 x 4 meters distance of planting with 24 to 28 plants per treatment.

The Research and Demonstration Areas were established in farms of three farmer cooperators in Abia’s Farm and PCC R&D Station in Ngaremlengui State, Gina’s Farm in Airai State in June 2006 and Rdiall’s Farm in Melekeok State, Palau, in October 2006. A Memorandum of Agreement was also signed between each farmer cooperator and PCC-CRE that defines the responsibilities of each party to successfully attain the objectives of the experiment. Bimonthly observations on the height of the pseudostem, number of suckers, total number of leaves and number of sick leaves were taken on banana plants in different treatments at the farmer's field. Weeding and removal of sick leaves infected with Sigatoka leaf spot and Black Leaf Streak were regularly done in the banana farms.

Results obtained in the experiments in the demonstration farms were presented in the Training on Banana Production conducted April 15-16, 2009. A Manual on Banana Production on Palau was produced and printed.

Research results and discussion:

Fertilization Experiment

Analysis of soils in the farms where the research and demonstration experiments were established revealed relatively low soil pH, low organic matter and very low levels of phosphorus and potassium (Table 1).

Results showed that in all the research and demonstration farms, “Lacatan” banana fertilized with manure and fertilizer every 2 months were consistently taller than those applied with manure and fertilizer at planting time only and those given manure only every 2 months (Fig. 7-10). Comparing the performance of plants among the different farms, those applied with manure and fertilizer every 2 months in Gina’s farm produced the tallest plants as shown in Fig. 14. Chicken manure and compost are widely used as organic fertilizer for crop production in Pacific island countries (Scully and Bevacqua, 1990). Likewise good growth, development and yield of banana were observed after application of N,P and K fertilizers.

On the other hand, Lacatan bananas that were given neither manure nor fertilizer showed the least growth and were the shortest among all the treatments in the experiment (Figs.7-10). This is especially evident in the experimental plants at the Rdiall Farm (Fig. 7) and at R & D Station (Fig. 8) wherein the banana plants were less than 50 cm in height at 12 months after planting (Fig. 11). This shows that the soil is really lacking in all the nutrients needed for optimum growth and development of banana. Fig. 12 shows the one-year old banana plants without manure and fertilizer (foreground) and with manure and fertilizer applied every two months (background). Although the unfertilized plants in Abia’s Farm managed to reach 75 cm in height (Fig. 11), this was still way below optimum growth. On the other hand, banana plants without manure and fertilizer in Gina’s Farm were the tallest compared to those in the other research and demonstration areas. They also had almost the same height as the plants applied with manure every 2 months and those applied with manure and fertilizer at planting time (Fig. 9).

Furthermore, highest sucker production was observed in the banana plants applied with manure and fertilizer every 2 months among all the different treatments in all the research and demonstration farms ranging from 2.9 to 4.3 suckers per plant

(Fig. 16). On the other hand, in Gina's Farm. Bananas in the treatment without manure and fertilizer also showed the second highest rate of sucker production. This is also due to the relatively high nutrient content of the soil before the start of the experiment as it was used for vegetable production and is very near a pig pen. Suckers were removed from banana plants with more than three suckers. Desuckering or removal of unwanted suckers is an important cultural management practice in banana production (Fig 17). Allowing too many suckers to develop at the same time results in small bunches and decreased productivity (Engelberger, 1982). Only three growing shoots were allowed to grow at any given time (Fig. 18). On the other hand, the areas where the research and demonstration experiments were set up at the R & D Station, at Abia's Farm and Rdiall's Farm were all newly opened and newly planted areas.

Weeding. Regular weeding in the research and demonstration farms was done every 2 months with the use of a grass cutter (Fig. 19). This was done in time for application of fertilizer treatments. Removal of the weeds reduced the competition of the grasses in the absorption of nutrients from the soil (Hazarika, 2002). This ensures that the manure and fertilizer applied to the banana plants in each treatment was used only by the banana and not the weeds around the plant.

Leaf Pruning and Leaf Diseases. Deleafing or regular removal of old diseased, non-functional and unwanted banana leaves was done regularly (Fig. 20). This lessens competition of suckers with old, hanging leaves and reduces the spread of pests and prevents the disease inoculum from spreading and further infecting the other healthy leaves (Engelberger, 1982). It was observed that the Lacatan variety of banana was very susceptible to Sigatoka leaf spot (Fig. 21) which is caused by Mycosphaerella musicola and is characterized by appearance of yellow specks, which elongates and expands into brown streaks. Another leaf disease, which is the most destructive disease in Palau, is the Black leaf streak (Fig. 22) caused by Mycosphaerella fijiensis, which is characterized by tiny brown specks that elongate into reddish brown streaks and later become dark brown or black. The rate of infection of the banana plants ranged from 35 to 78% (Table 2). It was also observed that plants that were fertilized with manure and fertilizer every 2 months had a relatively low level of infection compared to those without manure and fertilizer or those that were applied with manure and fertilizer at planting time only or those that were applied with manure only every 2 months. Strategies done to control the disease were removal of diseased leaves to reduce source of inoculum. This was done each time weeding and fertilization was done. This drastic reduction in leaf number also greatly affected flowering and fruiting of the plants.

Marasmiellus Disease. At one year after planting (June, 2007), an alarming incidence of Marasmiellus disease infection was observed in Abia's Farm (7–60%) and at the R&D Station (16-62%) in Ngaremlengui State and Gina's Farm (5–26%) in Airai State (Table 3). This disease, which is caused by the fungus Marasmiellus inoderma, is characterized by water-soaked lesions within the outer leafsheaths, death of outer leafsheaths and leaves, pink fungal growth often visible between the sheaths and fungal fruiting bodies (mushrooms) are produced in the pseudostem or debris on the ground (Fig. 23). The young emerging leaves and emerging flowers and fruits become smaller and aborted and the mother plant eventually dies (Fig. 24). It was really disappointing to see our experimental plants dying out due to this Marasmiellus disease. Some remedial measures were done such as fertilization and removal of infected leaf sheaths so the fungal infection would be under control (Fig. 25). In addition higher incidence of the disease was observed in the plants that received only manure and fertilizer at planting time or manure only every two months. After 14 months of the experiment, the unfertilized plants were given fertilizer, and when the plants were vigorously growing, a reduction in the incidence

of Marasmiellus was noted. Therefore, it is important to keep the plants well nourished and vigorously growing to reduce infection.

Flowering and fruiting. At 10 months after planting, flowering started in the treatments with manure and fertilizer every 2 months in Abia's Farm and Gina's Farm. At 14 months after planting (August, 2007), 70% flowering and fruiting was observed in the treatments with manure and fertilizer every 2 months in Gina's Farm (Table 4), while 42% flowering and fruiting was observed in Abia's farm. After the flowers have emerged and set fruit, deflowering was done, which involved removal of the flower bud, male inflorescence and extra flowers (Fig 26). This increases the finger length and reduces the fruit maturation period since there is less competitions for nutrients, which would now be more available to the fruits rather than to the inflorescence (Scully and Bevacqua, 1990). The fruit bunches were covered with a white polyethylene cover after deflowering (Fig. 27). This practice is recommended as it improves the quality of banana by creating the right environment for growth and protecting the bunch from external and insect damage (Engelberger, 1982; Choudhury and Chandra, 1996; Liu and Varitoga, 2004). As the bunches began to mature and become heavy, propping was done with the use of bamboo poles to help the pseudostem support the developing fruit bunch (Fig. 28), avoid breakage and uprooting by strong winds (Scully and Bevacqua, 1990).

Average yield observed in Abia's farm was 10.2 kg bunch weight with 92 fingers (Fig. 29), while in Gina's Farm, bunch weight was 14.7 kg with 172 fingers (Fig. 30). In Gina's Farm, 26% flowering and fruiting was also observed in the plants without manure and fertilizer with higher average bunch weight of 15.2 kg. However, only 5% of the plants in the treatments with manure and fertilizer at planting time were able to bear fruit with average bunch weight of only 10.5 kg. In Abia's Farm, fruiting was also observed in only 3.5% of the plants that received manure and fertilizer at planting time and those applied with manure only every 2 months. On the other hand, banana plants given manure and fertilizer every 2 months were the only ones that produced fruits at Rdiall's Farm at 16% with an average bunch weight of 8.4 kg and at R & D Station, which showed 25% fruiting with an average bunch weight of 11.1 kg.

Trip to Commercial Banana Plantations in Davao

The visit to commercial banana plantations in Davao City, Philippines, was not done on the first year of the implementation of the project due to administrative problems. Although the funding was available, the President of the Palau Community College granted approval to go on the trip to Davao only in the third year of the Project when we were already toward the end of the experiment. Hence, some important production practices were not properly done. Furthermore, the Project Cooperator who is a Crop Protection Specialist was not allowed to go on the trip to Davao. Instead, the Extension Agent was the one who accompanied the Project Leader on this trip.

Finally, our trip to Davao to visit commercial banana plantation was done on April 24, 2008. We had a tour of one of the farms of Lapanday Foods Corporation in Mandug, Davao City, courtesy of the Research Manager, Dr. Emily G. Fabregar. We first visited the banana tissue culture laboratory and were given an overview of their tissue culture operations. Shoot tip culture of banana involved several stages (Fig. 31) and was used at a maximum efficiency at the same time taking care not to produce somaclonal variation in the planting materials produced by maintaining their stock up to 5 subcultures only. They have a staff of 20 propagators doing the inoculation and planting the bananas in the culture media all day (Fig. 32). The laboratory could produce 100,000 banana meriplants a month for the Company's needs and for sale to local growers. Planting materials are sold direct from the

bottles or ready to plant in the field. The meriplants produced in the Laboratory are then acclimatized in the greenhouse until they are ready for field planting (Fig. 33 and 34).

In the field, we observed the high density planting being practiced in the plantation wherein the bananas are planted at 2 x 2 m apart (Fig. 35). Deep ditches are provided for good drainage in the farm (Fig. 36).

In the banana plantation, we were shown where and how to apply fertilizer (Fig. 37) and how to determine which suckers to leave on the mat to have optimum plant development (Fig. 38). Other technologies taught were when and how to do the propping and removal of the flag leaf, (Fig. 39) removal of flower before bagging (Fig. 40), when to remove the flower bud (Fig. 41), and also the bagging operation (Fig. 42). Regular removal of diseased and old leaves was done on a weekly basis. For Cavendish banana, ideally, there are three generations in one mat (the mother, the follower and the sword leaf sucker). Also there should be 12 leaves and 9 hands at flowering, and to produce a heavy bunch at harvest time, there should be 9 leaves and 9 hands. The bunches of harvested bananas are brought to the packing house by a cable system where they are separated from the bunch (dehanding) (Fig. 43).

In the packing house, the bunches are washed with high pressure washer to remove any dirt or insects in between the fingers. The hands are then separated from the bunch and then immediately placed in washing tanks (Fig. 44). The hands may be separated into 5 finger groups to fill up some orders for smaller packaging. The cut portion of the hands is treated with alum and a fungicide to prevent rotting during storage and shipping. The bananas are labeled (Fig. 45) and packed at 5 hands per box (Fig. 46) or in crates containing the 5-finger groups. Air is sucked from the plastic bags before it is sealed in the box (Fig. 47). Within the day, the boxes (Fig. 48) and crates are loaded into refrigerated vans to be loaded and shipped to destined markets such as Japan, Korea, China or the Middle East.

It is quite unfortunate that this trip to commercial banana farms was done only in April 2008 when the experiment was finished. Thus, we were not able to implement in the research and demonstration farms the appropriate cultural management practices to attain optimum growth and development of banana. For example, we learned that the bananas can be planted at a distance of 2 m apart so more plants can be accommodated per unit are. Furthermore, fertilizer application should be done every month, to ensure healthy vigorously growing banana plants. The proper way of propping and bagging or sleeving the fruits was not done, as well as appropriate harvesting and fruit care to ensure good quality fruits in the market.

Training on Banana Production

When substantial data has been gathered and the differences between treatments were evident in the farms, a Training on Banana Production was scheduled to enable us to disseminate the results of the Project to the Community. Invitations were sent out to Governors of the 16 States of Palau (Appendix 8) as well as to farmer organizations. Several participants from the different states responded to the invitation and the Training was conducted on April 15 - 16, 2009, at the Conference Room of the PCC Research and Development Station in Ngermeskang, Ngaremlengui (Fig. 49). The first day of the training consisted of lectures and PowerPoint presentation (Fig. 50) on the various benefits from banana, different banana varieties on Palau, propagation, planting and cultural management practices, pests and diseases and fruit care (Appendix 9). The second day of the Training was devoted to field trip to the research and demonstration farms at the R & D Station (Fig. 51), in Melekeok State where Rdiall’s Farm was located, to Airai State where Gina’s Farm was located and to Ngaremlengui State where Abia’s Farm

was located. During this field trip, the participants listened to farmer cooperator who was able to discuss with the training participants his experiences in growing the banana for the past year and a half (Fig. 52); they saw the actual effect of the fertilization treatments on the growth of the banana plants and they were convinced that it is really important to apply fertilizer regularly to banana in order to ensure a good harvest of fruits. A total of 36 participants completed the training (Appendix 10), and during the closing ceremonies each participant was given a Certificate and was provided with a copy of the Manual on Banana Production on Palau and a "Lacatan" banana sucker to plant in their backyard (Fig. 53).

Research conclusions:

The results of the project clearly demonstrate the need to maintain healthy and vigorously growing banana plants in Palau in order to achieve good harvest. This could be attained by regular application of complete fertilizer and manure to ensure proper nutrition of bananas. The use of chicken manure alone as fertilizer is insufficient for the optimum growth of bananas as it supplies only nitrogen. Adequate supply of phosphorus and potassium is needed for vegetative and reproductive development. Furthermore, vigorous vegetative growth of banana ensures low incidence of leaf and stem diseases.

The training conducted on Banana Production in Palau has ensured that the information generated from the project has been disseminated to interested farmers. The field trip was an eye-opener for them to realize the importance of feeding the banana plants to ensure healthy and vigorously growing plants. It is time for farmers to take care of their crops and not just plant and forget and comeback to the farm when it is time to harvest. Harvesting will not be realized if you do not take care and feed your crops regularly.

Participation Summary

Educational & Outreach Activities

PARTICIPATION SUMMARY:

Education/outreach description:

A 58-page Manual on Banana Production on Palau (Fig. 54) was produced during the later part of the Project so farmers will have a guide on the appropriate cultural management practices to be done in order to successfully grow banana on Palau. One thousand copies of the manual were printed and the participants of the Training on Banana Production conducted last April 15 to 16, 2009, were the first recipients of the Manual. Other copies of the Manual were distributed to government agencies, State Offices, farmers and community organizations and other individuals interested in growing banana.

Project Outcomes

Project outcomes:

Yield of banana per hectare as affected by the fertilization treatments was

estimated based on the number of plants fruiting and the average bunch weight (Table 5). From these, estimated income was derived based on the market price of banana at $1.50 per kg. This experiment clearly shows that best yield and income are obtained when bananas are applied with manure and fertilizer every 2 months. Highest yield and income was attained in Gina's Farm which gave a yield of more than 8 tons per hectare and a potential income of more than $13,000. Even if the plants were not applied with manure and fertilizer, more than 2 tons of bananas can be harvested with an estimated income of more than $3,000. In newly opened areas, bananas cannot grow well without manure and fertilizer, especially at the Abia's Farm, at the R & D Station and at Rdiall's farm. Income can only be realized if the bananas are fertilized with manure and fertilizer every 2 months.

Farmer Adoption

After the Training, PCC-CRE received many inquiries on the availability of banana planting materials from those who were interested in setting up a banana farm. In addition to those who participated in the Training, we were able to assist 7 farmers establishing a small banana enterprise by providing compost and planting materials of Lacatan and "Mechad" banana varieties. Their farms were located in several states of Palau, namely in Koror, Ngarchelong, Ngiwal and Ngchesar. We will continue to provide technical assistance to these farmers to follow the recommended cultural practices for successful banana production such as fertilization, leaf pruning and removal of diseased leaves and removal of excess suckers from the banana mat. We hope to achieve an increased production of banana in Palau.