On-Farm Implementation and Demonstration of Integrated Sustainable Agriculture, Livestock Production, Composting and Soil Improvement Systems for Small-Scale Farmers in Micronesia

Virendra M. Verma
Micronesia Plant Propagation Research Center, Agricultural Experiment Station and Cooperative Extension, College of Micronesia-FSM, Kosrae, Micronesia

INTRODUCTION

The Federated States of Micronesia is made up of 607 small islands spread over a million square miles of the Western Pacific Ocean. However, the total land area is only about 271 square miles. The islands of Micronesia are striving towards self-sufficiency while mindful of high malnutrition and an enormous trade imbalance attributable to importing foods. Very little food crops are cultivated at the local level and most of the foods available at local markets are imported. Due to high shipping cost, these are very expensive and unaffordable for average local people. And even after paying high-prices, people are not able to get fresh produce because of long transportation time. Although current agriculture programs are mostly on subsistence level, food crops and swine production are considered primary and important industries in Micronesia. Almost every household on the island has swine production operations with capacities that range from a few animals to about twenty-five animals and backyard gardening. These operations may be small, but they are numerous. Local people mostly rely on banana, breadfruit and taro as main source of food for themselves and also for livestock; however, their needs are usually much greater than the available food supplies. Taro and pigs are part of many traditional and cultural practices. Value of taro and pigs is closely related with demands during funerals, annual feasts and daily community functions and activities. The present paper discusses the research and extension work done to meet this ever-increasing demand for food and feed through increasing agricultural production by generating the ability to successfully raise livestock, and grow food and feed crops for sustenance by training local farmers in appropriate and skillful use of sustainable and integrated agriculture systems.

ACCOMPLISHMENTS

Objective 1: Develop and implement cropping systems for multipurpose crops to maximize production in sustainable manner

Multiple integrated activities were organized for dryland and wetland cropping systems, and swine production to minimize external inputs as much as possible. Demonstration plots at the pilot site and producers' sites were developed and dryland and wetland cropping systems for sweet potato, taro, banana, eggplant, papaya and kangkong were established. The selection of target crops was made on the basis of traditional value of the crops and also on the nutrient deficiencies commonly present in the local community. Considering the high rate of vitamin-A deficiency and iron deficiency especially among local women and children, two yellow-fleshed sweet potato varieties and papaya (due to high beta-carotene content), and eggplants and kangkong (due to high iron content) were included as target crops along with traditionally valued taro, banana and swine. Planting materials for sweet potato, taro, banana and kangkong were multiplied through tissue culture at the Kosrae Agricultural Experiment Station (KAES) and used at all sites for planting. Hybrid seeds were used to prepare papaya and eggplant seedlings at the KAES. Sweet potato and taro were planted on raised beds to provide desired depth for storage root and corm development, and for proper water drainage. Compost along with little inorganic fertilizer was used for top and side dressings. Bananas were planted in rows. The holes were dug directly into the ground. The bottom half of each hole was filled with compost and the top-half was filled with amended soil. Taro and kangkong were planted as wetland crops and treated effluent from piggery was used to fertilize the crops. Eggplants and papaya were planted in rows and compost along with little inorganic fertilizer was used for soil amendment before planting, and later for side dressings.

Objective 2: Develop and implement swine production system based on locally available resources for small-scale farmers

Sweet potato and kangkong leaves were used regularly to provide protein and dietary fiber to swine. During harvesting season, swine were also fed on surplus sweet potato storage roots, taro corms and banana fruits to provide carbohydrate. It is clearly evident that modified diet based on locally grown crops could efficiently and completely substitute the usual commercial swine feed. However, the farm areas at all sites need to be expanded and systematically maintained in order to feed swine throughout the year on modified diet based on local resources.

Objective 3: Develop and implement simple techniques to optimize the use of different components of crops for different end purposes, such as food, feed and nutrients for plants

Sweet potato storage roots, taro corms, eggplants and banana fruits were used as source of carbohydrate, vitamins and minerals primarily for human consumption, and excess produce was used as swine feed. Sweet potato and kangkong leaves were used as source of protein and dietary fiber for human consumption and swine feed. Swine manure, effluent from piggery, crop residues and byproducts from farm were recycled through on-farm composting or treatment, and utilized as organic nutrients at all sites to fertilize all crops to minimize the use of commercial inorganic fertilizers.

Objective 4: Implement recycling of animal wastes and crop residues through composting

Organic matters such as banana pseudostem, leaves, fruit peels; taro petioles, excess leaves, corm peels; sweet potato and kangkong petioles, and vines, excess leaves; and swine manure were used for composting. Solid swine manure was separated from the piggery effluent by using a rundown screen and sun dried for two weeks. Dried solid manure was shredded along with the dried organic materials such as crop residues, and was used as brown material for composting. All fresh and green organic materials were shredded while still fresh and were used as green material for composting. Effluent from the piggery was collected in cement tanks after solid removal through rundown screen. Five percent of shredded green crop residues by volume were added in the collected effluent and mixed thoroughly. The mixture was allowed to decompose through aerobic microbial activity for initial 2-3 days and later on left for anaerobic fermentation for 7-8 days. The treated effluent was diluted and released directly into the plots for wetland crops and was also used to maintain moisture content in the compost pile. Hot composting technique was implemented to convert the nutrient-rich crop residues and swine manure into valuable compost. A six inch layer at the bottom of the compost pile was filled with coconut husk for better air circulation. Green (nitrogen rich) and brown (carbon rich) materials were layered alternately and on each layer a half inch thick layer of finished compost, and fresh and healthy soil from the forest was added as an activator. Aerobic process was used for decomposition of organic matters. High microbial activities generated heat that was regulated and maintained within the required range of 140-158^{o}F in the composting pile by appropriate air circulation and proper moisture maintenance during heating phase. The pile was turned once in a week and treated effluent from the piggery was sprayed to control and maintain appropriate temperature and moisture, respectively. The heating phase gradually changed into a cooling phase and decomposition occurred without much generation of heat, and temperature dropped slowly up to 86^{o}F. At the end of decomposition, during the maturation phase, the temperature dropped between 68-77^{o}F and resulted in finished compost. This ecologically integrated and well managed system composted the manure, spilled feed and crop residues in less than 3 months.

IMPACTS

Project coordinator and producers maintained a high level of interest for developing and implementing multiple integrated activities for dryland and wetland cropping systems, and swine production in a sustainable manner. Demonstration plots have been developed at the pilot and producers' sites, and are being maintained. These sites are being used for demonstration of planned outreach activities to encourage establishment of integrated sustainable agriculture, livestock production, composting and soil improvement systems. At the project sites, vigorously growing crops, harvest of excellent sweet potatoes, bananas, eggplants, healthy taro crops and swine along with sustainable and fast composting techniques have attracted much attention of local communities. Many people have shown enthusiasm to participate in project activities. Harvested eggplants from the project's pilot site were showcased during State Agriculture Fair 2010 and 2011 were awarded with the first, second and third prize for vegetable/eggplant category.

1. Tissue culture multiplication; 2. Nodular structures; 3. Green shoot buds; 4. Multiple shoots; 5-6. Well-rooted plantlets, 7. **Planting material of banana, 8. Planting material of taro, 9. Sweet potato and taro planting at producer's site, 10**-11. Application of compost by side-**dressing at producer's site, 12. Field view of sweet potato cultivation at pilot site, 13**-14. Field view of bana**na cultivation at producer's site, 15. Close**-up view of taro row, 16. Field view of taro cultivation at pilot site, 17. Close-up view of sweet potato row, 18. Field view of sweet potato cultivation at pilot site, 19-20. Feeding swine on modified diet based on local resources at pilot site, 21-22. Harvested sweet potatoes from pilot site, 23-24. Close-**up of banana bunch at producer's site, 25. Fie**ld view of eggplant cultivation at pilot site, 26. Harvested eggplants from pilot site (Winner Produce of the State Agriculture Fair 2010 and 2011), 27. Close-up view of eggplant plants at pilot site, 28. Planting material of papaya, 29. Shredded green material for composting, 30. Shredded brown material for composting, 31. Coconut husk used at base for better aeration, 32. Finished compost and fresh and healthy soil used between the layers as an activator, 33. Hot composting technique: Shredded green and brown materials arranged in layers, 34. Close up view of green and brown layers in compost pile, 35. Heating phase: One week old compost pile, 36. Maturation phase: Finished compost ready to use.

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