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Factsheet

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Atolls' Climate Smart Compost and Irrigation

Purpose:

To explain and promote new approaches to soil development using compost and simple drip irrigation in Pacific atoll countries. These approaches help communities grow their own fresh vegetables to contribute to food security and good nutrition. The Pacific Climate Smart Agriculture community alliance helps to share these ideas between different communities.

Key Message:

Atoll islands have some of the poorest soils in the world, making it difficult to grow plants. The impacts of climate change such as longer dry seasons, vulnerability to rising sea levels and soil salinity are worsening the problem. Recognising their vulnerability to the climate, Pacific atoll communities are sharing ideas and trialling practical solutions to make their limited water go further, and to improve the fertility of their soil. These 'climate smart agriculture' discussions and approaches emphasise many traditional practices, assisted by some basic science. This factsheet briefly describes some of these approaches, such as saving open-pollinated seeds, monitoring soil health, fallow crops, targeted composting and installing drip irrigation systems.

The Global Climate Smart Agriculture Alliance

The Pacific Community (SPC) has been facilitating the formation of the Climate Smart Agriculture (CSA) community alliance in the Pacific. The three key pillars of CSA aim to encourage:

1. increased productivity on farms and better incomes for farmers;
2. increased resilience to withstand growing climate variability (such as longer dry seasons;) and
3. reduced greenhouse gas emissions.

The Pacific CSA alliance is part of a global movement, with alliances formed in many parts of the world.

Composting to improve soil quality is a key component of improved Climate Smart Agriculture (CSA).

Challenges to Growing Nutritious Food

Atoll communities in Tuvalu, Kiribati, Tonga and the Royal Marshall Islands (RMI) are developing their own resilience strategies to increase the amount of nutritious food that they can grow for themselves. These community-led approaches are being assisted by the Pacific Community (SPC) and the Pacific Climate Smart Agriculture (CSA) community alliance.

Solutions include greater use of open-pollinated seed collection and extraction so that seeds (taken from the best fruit only) can be saved and used for planting in the next year (Figure 1), the use of nitrogen-fixing fallow crops (Figure 2), soil chemical testing and improving compost (Figure 13), and simple drip irrigation systems.

Figure 1. Open pollinated tomato, chilli and Hawaiian papaya fruits that were bagged for seed production.

Figures 2. Mucuna (*Mucuna pruriens*), is a nitrogen-fixing cover crop which can also shade out many other weeds. Mucuna grown in sandy soil (right) shows signs of chlorosis (yellowing), probably due to iron (Fe) deficiency.

Community Driven Approach

For communities to drive their own solutions, discussions have been convened by SPC scientists to develop communal understanding of the options for responding to longer dry seasons, and other effects of climate change. In particular, issues discussed include vulnerability, sensitivity and ability to adapt (i.e. 'What are the problems?' (Figure 3); 'How big are the problems?' (Figure 4) and 'What can we do about the problems?' (Figure 5).

Figure 3. Example from Tonga workshop of assessment of exposure to increased climate variability.

Parameters	Indicators	Perceived changes (What are the problems?)
Temperature	• Numbers of hot days increased • Number of cold days decreased	High
Precipitation	• Rainfall has decreased and become increasingly unpredictable	High
Plant indicators	• Flowering and fruiting of some of the fruit trees like breadfruit and mango	High
Climate induced disasters	• Drought (more recently) • Hurricanes (season longer and stronger)	High Med - High
	Average Exposure index	High

Figure 4. Example from Tonga workshop of assessment of sensitivity to increased climate variability.

Parameters	Hazards	Indicators	Perceived changes/ remarks (How big are the problems?)
Agriculture and food security	Hurricanes	Trees fell and crops destroyed	V. High
	Drought	Crops die and loss of production	High
	Outbreak of diseases	Harder to farm and use more chemicals	High
Forest and biodiversity	Drought	Trees die and loss of forest cover	Med-high
	Hurricane		
		Trees fell and loss of cover	High
	Fires	Loss of forests and residents/farms	High
Infrastructure	hurricanes	Trails and roads damaged	High
Water resources	Hurricanes	Loss of quality fresh water	High
	Drought	Reduction of freshwater	V. High
Human health	Hurricanes	Emergence of waterborne diseases	V. High
	Drought	Disease outbreaks like conjunctivitis	High
Average Sensitivity Score			High

Figure 5. Example of community self-assessment of their own adaptive capacity to increased climate variability.

Parameters	Criteria (What can we do about the problems?)	Perceived changes
Human assets	Old age and children	Medium
	Community productivity	Medium
Natural assets	Land Quality and resilience	Medium
	Forest Quality and resilience	Medium
	Quality and availability of drinking water	Medium
Financial assets	Banks, cooperatives,	Low - Med
	Income sufficiency for household needs	Medium
Social assets	Service delivery (Government, Non-Government)	Medium
	Social networks (women, men, youth)	Medium
Physical assets	Road access	Medium
	Water facilities	Medium
Average Adaptive Capacity Score		Medium

Community ideas for some solutions are given later (see Climate Smart Agriculture box), but science guides these solutions, with soil testing, targeted composting and drip irrigation.

Why is Soil Testing Important?

Soil tests help to tell us what is limiting a plant's growth. CSA communities are moving towards more regular use of basic soil tests to identify what may be limiting plant growth (Figure 6). Using this information, compost can be added to the soil to replace missing nutrients. In particular, the atoll trials are using targeted compost, which is compost that specifically includes nutrients that are most needed by atoll soils.

Figures 8. Example of a soil testing trial established in the Royal Marshall Islands. Results showed the sweet potato plot in Laura had nutrient deficiencies. Also red stemmed taro grew much better than the green stemmed taro.

Simple Science for Testing Soil Nutrients

Simple soil trials quickly determine what nutrients are lacking in the soil, and provide a baseline for monitoring changes in the soil over time.

This testing can be done easily by farmers, with the results used to generate significant benefits to soil nutrition and therefore plant growth. At a CSA workshop in Tonga, the list compiled by participants (Figure 6) demonstrated how simply and quickly testing can give guidance to farmers. The results were:

- pH looks okay (i.e. the soil is not too acidic or too basic for plant growth)
- 8 farms had trace Nitrogen (N) levels (very low), 5 were low, 6 were medium
- 14 farms had trace Phosphorus (P) levels, 2 were low, 1 was medium and 2 were high
- 1 farm was low in Potassium (K), 2 were medium and 16 were high.

Figure 6. Soil test kits involve mixing the soil with particular solutions and comparing the colour of the mixture with a standard chart. Different solutions are used to test pH and each of the elements.

Through CSA initiatives, farmers in the target communities have their soil samples analysed using simple soil test kits (Figure 6) to determine what elements or nutrients the soil lacks that is limiting the growth of their plants (assuming that they are not limited by lack of water).

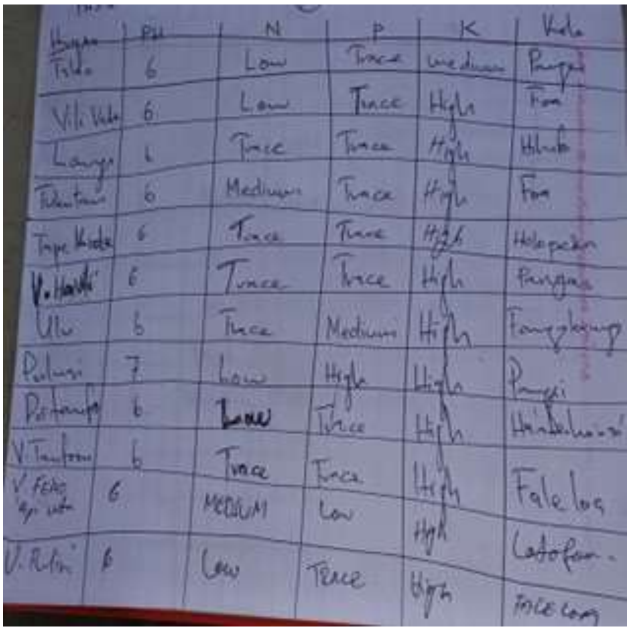
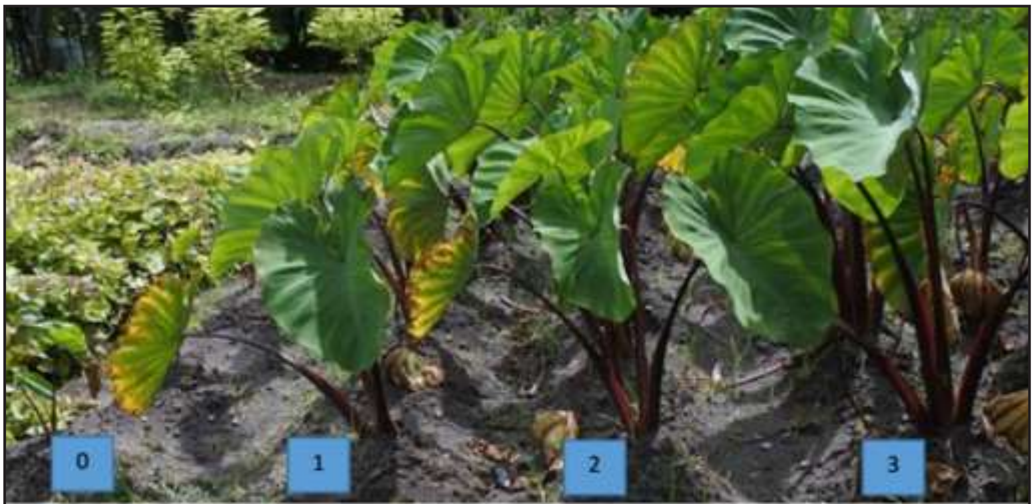


Figure 6. Tonga workshop tabulation of soil chemistry results showing pH, Nitrogen, Phosphorus and Potassium levels. From the soil tests the community quickly gets information about what kind of food the plants need.

Using taro (Figure 9), soil tests were conducted based on a control plot of taro (0) alongside various levels of taro with nutrients and micronutrients added including Iron (Fe), Copper (Cu) and Manganese (Mn). As illustrated in Figure 9, the main change (from left to right in the photo) was due to increasing the available Phosphorus (P) for the taro plants. The pH did not differ much whereas electrical conductivity (a measure of nutrient availability) increased when compost was applied. Compost application also increased the levels of the major plant nutrients Nitrogen, Phosphorus and Potassium. The nutrients Iron, Copper and Manganese can limit plant growth; it is critical that they are present, but only in small quantities. The integrated effects of these higher levels increased the growth of taro.



pH	8.12	8.2	8.2	8.2
EC	65	120	130	140
N	6.7	40	44	44
P	17	33	46	50
K	35	50	52	56
Fe	1.3	3.2	2.4	3.4
Cu	1.4	4.2	3.2	4.0
Mn	0.2	0.2	0.2	0.2

Figure 9. Trial site showing from left to right, a control line and increasing additions of compost.

Smart Farming Systems for Compostand Irrigation

The concept of smart farming applies modern approaches and different technologies to increase the efficiency of agricultural production. The CSA communities trialled some of the many smart farming approaches, with a focus on soil improvement and maximising usage of limited water supplies.

Alley Cropping

An alley cropping system is a structured way of growing a mix of crops together. An example of an alley cropping system in Kiribati (Figure 10), started with the community designing the layout, then clearing the land and planting trees in lines, or rows, to provide shade for the vegetables. Community members then composted the soil and planted vegetables on top of the localised compost.

Figure 10. In Kiribati, marking the alley cropping field and planting the alley trees of drum stick (*Moringa oleifera*) and Ofenga (*Pseuderanthemum* spp.)

Climate Smart Agriculture

Some of the ideas from communities in the Pacific that alleviate impacts of increased climate variability and ensure they can still grow food included:

- Using the 'seed saver' approach to ensure that seeds from preferred plants are kept for the next year's planting
- Crop-Livestock systems -Crops and livestock can and should be integrated, with crops protected from livestock but supplying fodder to them, and the animal manure being returned to the plant gardening areas
- Biodiversity and resilience -a simple way to build resilient agricultural systems in the Pacific is to plant trees and garden in between them. Trees supply nuts and fruit, shade (especially for young plants), protection for the soil and they can lift nutrients from deep in the soil back to the surface where they can be used by other plants.
- Adapting crop varieties - Materials from the Centre for Pacific Crops & Trees (CePaCT) will still need to be evaluated for local conditions, and further developed by farming communities, to make sure that they are most suited.
- Adopting a holistic approach to the resources available to the community that come from outside the garden itself, such as insect pollinators and the water from the catchment.

Mitigation/Adaptation

- Crop residues: Always return crop residues to the soil to build soil organic carbon (SOC). Don't burn anything unless absolutely necessary to control a disease outbreak.

- Nitrogen fixing: Use nitrogen fixing cover crops such as Mucuna 'magic beans' as a fallow crop

- Strive for minimum tillage of the soil: Every time soil is cultivated it releases soil carbon to the atmosphere, where plants can't use it. Cultivation should always be kept to the absolute minimum necessary to manage weeds.

- Irrigation and mulches: Mulches make irrigation more efficient by keeping the soil cooler and reducing evaporation and increasing the amount of water held in the rooting zone of the plant.

- Agro-forestry and home gardens: Pacific mixed cropping systems are very productive, and mixing trees and crops ensure that sites are fully utilised.

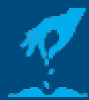
Climate Services

- Use weather forecasts to support crop planning. Short term forecasts and seasonal outlooks are available from most national meteorology services, and use models (SCOPIC and POAMA) to predict the likelihood of above- or below-average rainfall. These can assist with planning the timing of planting and harvesting.

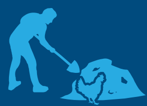
Climate smart. But how?

Using weather forecasts for planning

Targeting water use to the plants that you want to grow



Using seeds that have been bred to survive new conditions



Keeping plant nutrients where the roots can reach them (not washing them out, or sending them into the sky)

Sharing market information and working in groups

Making compost

In the atoll nations, targeted compost solutions are needed that feed the soil and keep nutrients around the plant roots.

To find the best targeted compost solution communities have been working with CSA partners to analyse the respective atoll's soils to specify which nutrients are lacking; then to develop compost that includes the missing nutrients - ideally using local sources rather than expensive imports. The final stage is trialling and refining the targeted compost .

Burying the compost

Trials are suggesting that the best way to use very limited amounts of compost is to place it at a depth of 20-30 cm and then cover it again and plant (Figure 12). This way the nutritional benefits of the compost last longer. More information is available from the POETCom website http://www.organicpasifika.com

Drip irrigation systems

Farmers are using very simple bucket irrigation systems to achieve precision placement of small amounts of water using drip irrigation technology, close to the plant roots.
There are a number of commercial products around for these systems. Low density polyethylene pipe (13mm diameter) can be used for supply lines. Drip tapes can be purchased with emitters spaced from 10 to 60 cm apart and can achieve uniform distribution of water to all plants along the line.

Figure 11 shows the layout of the dripper tape which is gravity-fed from an elevated bucket. In the adjacent rows the soil has been covered with coconut fronds to help reduce the soil temperature and reduce water evaporation.

Figure 11. layout of dripper tape. The blue bucket supplying the water to the plants can be seen at the end of the row. A strong fence around the garden excludes pigs.

Conclusion

Climate Smart Agriculture (CSA) discussions and approaches are being used in atoll communities to improve plant growth and productivity, with a particular focus on improving the poor quality of atoll soils and maximising usage of limited water supplies. CSA approaches emphasise many traditional practices, assisted by some basic science and modern technology.

CSA trials indicate that significant improvements can be made to productivity through basic approaches such as targeted composting and drip irrigation – promising to assist communities with improved food security and nutrition.

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