

# ARNO FARM: REPLANTING FOR SELF RELIANCE

Project Undertaken by:

The Ministry of Resources and Development  
Republic of the Marshall Islands

With Technical Assistance from:

The University of Oregon Micronesia  
and South Pacific Program

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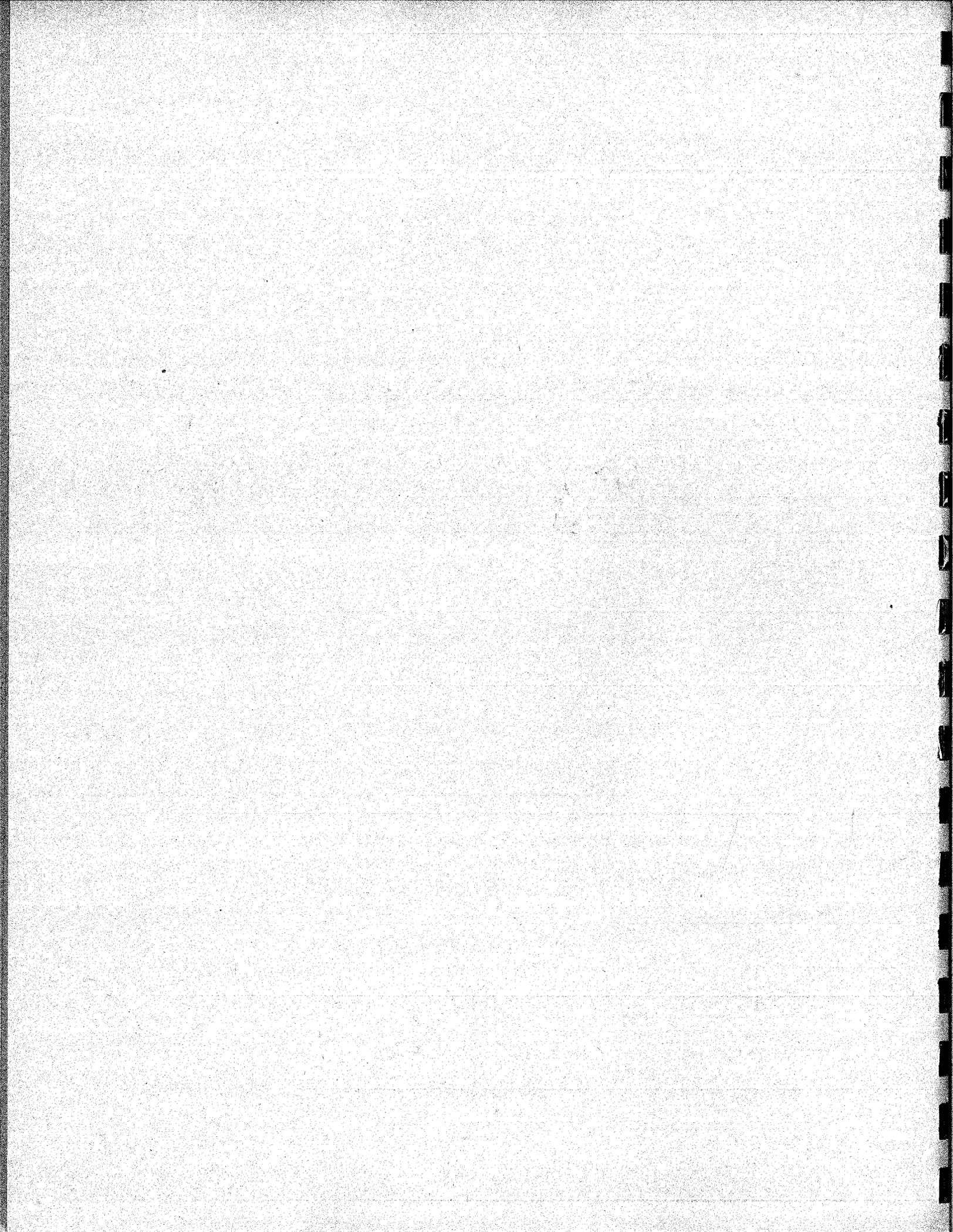
## Acknowledgements

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## EXECUTIVE SUMMARY

### INTRODUCTION

The Marshall Islands, once self sufficient in food production, have become dependent on imported foods. In addition to the economic problems created by this situation, the Marshallese people suffer a high incidence of malnutrition and diet-related diseases.

In an effort to address these problems, the Ministry of R&D, Agriculture Division has developed its Replanting for Self-Reliance Program with the following goals:

- Promote opportunities for increased production of basic staple crops.
- Promote higher yielding varieties of root crops and improved fruit tree varieties.
- Provide training and technical assistance in the crop scheme.

Toward these ends the Arno farm was chosen as one of the nurseries and distribution points for plant materials. The RMI Ministry of Resources and Development requested technical assistance for the project from the University of Oregon Micronesia and South Pacific Program and a technical assistant was assigned to the project for a three month period, June-September 1993.

### ACCOMPLISHMENTS

The Arno farm team, composed of the farm manager, the MSPP technical assistant and three Job Training Program workers were supervised by the Chief for Agriculture in Majuro. During the project period, the team accomplished the following:

- **Farm Plan** - The team located cultivated areas, ditches and buildings on the farm. Beds and fields which were developed during the project period were measured and the plan, included in Appendix A, was drawn up.
- **Farm Inventory** - Supplies and equipment were inventoried. See Appendix B.
- **Nursery Project - Planting Taro, Banana and Breadfruit** - 2,346 taro setts, 486 banana eyes and 295 root cuttings of breadfruit were planted. A list of varieties planted is included in Appendix C.
- **Food Plant Distribution** - Although all of the nurseried food plants were not ready for distribution at the end of the project period, some plants were distributed during the three months. A list of distributed plants is included in Appendix C.
- **Pesticide Identification and Disposal Project** - The pesticides stockpiled at the farm

were identified and placed in labeled plastic bags for shipment to the Environmental Protection Authority in Majuro. A list of the pesticides is included in Appendix B.

- **Vegetable Seedling Production and Distribution** - Seeds of eight varieties of vegetables were sown and some of the seedlings were distributed to the community. Some recommendations for improving this aspect of the farm project are included in the Recommendations. Appendix C contains a listing of the vegetable plants produced and their distribution.
- **Annual Seed Sowing Schedule** - A schedule was developed for producing vegetable seedlings on a four month cycle, facilitating distribution of seedlings to community members. The schedule is contained in Appendix D.
- **Soils Information** - The soils of the Arno farm were researched and investigated. A description of the soils present and some suggestions for managing them are included in Appendix E.
- **Mixed Garden Bed Development** - In order to have a garden bed in which mixed gardening could be demonstrated, we developed a large bed based on the compost pit method.
- **Garden Pit Development Instructional Leaflet** - A flyer was made explaining how to prepare a pit for planting bananas or other food plants. The flyer illustrates the process and has accompanying Marshallese text. A copy of the flyer is included in Appendix F.
- **Fertilizer Information** - Three tons of fertilizer chemicals were identified and inventoried and instructions for their use were compiled. The instruction sheets are included in Appendix G.

## RECOMMENDATIONS

The following recommendations are made based on information gathered during the project period:

- **Focus efforts on nutritious plants** - The vegetable distribution program should focus on crops such as bele, chili peppers, pumpkins and kang kong which supply nutrients that are known to be lacking in the local diet.
- **Signage for the Arno farm** - A sign at the gate should identify the farm as a public project. Another sign near the gate will tell when the next plant distribution is scheduled. Other signs will label plant varieties in the fields.
- **Barter plant starts for needed indigenous fertilizers** such as coconut husks and

manures - Will help to supply the farm with needed organic material and will raise awareness of the use of indigenous soil-enriching materials.

- **Establish a policy of mulching fields** - Will improve the soil, decrease the need for irrigation and weeding and will set an example of good gardening practices.
- **Establish a policy of not burning organic wastes** on the farm - Will provide organic material for soil improvement and again, will set an example of good gardening practices.
- **Stockpile organic materials** - Will provide readily available source of husks, fronds, compost, and other materials for use in planting pits and soil improvement projects.
- **Plant markinenjojo (*Vigna marina*) as a cover crop** in unused fields - Will improve the organic matter content of the soil and increase the available nitrogen.
- **Replace the roof of the shade house** - A transparent acrylic or fiberglass roof will protect the seedlings heavy rains and reduce leaching of the germinating soil.
- **Establish a policy for pesticide use** and provide training for applicators - Will reduce the likelihood of contaminating the groundwater, from which atoll residents get much of their water.
- **Detail equipment or crews to the Arno farm** - Will allow for most efficient use of equipment and manpower.
- **Facilitate intra-atoll travel by extension agents** - Providing access to boats and vehicles or providing gasoline with which to barter for transportation will enable extension agents to improve their outreach and distribution programs.
- **Require monthly reports of extension agents** - Will encourage proactive thinking and planning on their part and will facilitate budgeting and supply and equipment provisioning.



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## INTRODUCTION AND BACKGROUND

### Traditional Food Production

As a result of many political, economic and sociological factors, the people of the Marshall Islands, once self sufficient in food production, have become dependent on imported foods. Storms, pests, diseases and irregular rainfall can result in low production or complete loss of traditional food crops such as breadfruit and people must rely on rice, canned meats and other imported foods. At the same time the importance of the home garden as a food source and the consumption of locally-produced, traditional foods has decreased.

In addition to the economic problems created by this situation, the Marshallese people suffer a high incidence of malnutrition and diet-related diseases. A recent analysis of the diet of Marshallese children on Arno atoll indicates that over 40 % of children under 15 suffer significant malnutrition, (Calf, 1993). Iron and vitamins are typically lacking in the diets of these young people. Among older Marshallese people diabetes is common.

### The Replanting for Self-Reliance Program

The Ministry of R&D, Agriculture Division has identified three goals for its Replanting for Self-Reliance Program:

- Promote opportunities for increased production of basic staple crops and vegetation.
- Promote higher yielding varieties of root crops as well as improve fruit tree varieties.
- Provide and conduct training and technical assistance in the crop scheme.

Toward these ends the Arno farm was chosen to be one of the nurseries and distribution points for plant materials shipped to the Marshall Islands from Kosrae in the Federated States of Micronesia. The Arno farm will plant, raise and then distribute several varieties of banana and breadfruit plants, and both *Colocasia* and *Xanthosoma taros*.

The RMI Ministry of Resources and Development requested technical assistance for the project from the University of Oregon Micronesia and South Pacific Technical Assistance Program for a three month period, June-September, 1993.

### The Arno Farm

For the past several years the Agricultural Division of the Republic of the Marshall Islands Ministry of Resources and Development (R&D) has operated a demonstration farm on Arno Island, Arno Atoll. The farm was developed in the late 1980s with the assistance

of agriculture aide workers from Taiwan. During this period papayas and vegetables such as tomatoes, peppers, pumpkins and cabbage were grown.

The Taiwanese left the Arno farm after a few months. By 1993 much of the original equipment on the farm was in a state of disrepair: the irrigation pump, tractor, small tiller, pickup truck and generator were not in working order.

During the development of the farm and the period when it was managed by the Taiwanese the farm had a staff of several Marshallese workers in addition to the two advisors. Current staffing includes one extension agent/ farm manager and three Job Training Program (JTPA) youths who worked during the June-August 1993 school vacation.

## METHODOLOGY

### **Structure of the Project Team**

The technical assistant lived on the Arno farm for the duration of the project. He worked with his counterpart, the Farm Manager, on a daily basis setting goals, identifying needs, planning and working in the fields. The Arno Farm team also included a staff of three JTPA workers who provided additional person power for the work on the farm.

The TA/Farm Manager team reported to the Chief of Agriculture who worked in the Majuro office of the Ministry of Resources and Development. The Chief scheduled transfer of plant materials from the Laura farm, obtained supplies and provided technical support.

### **Work Schedule for the Project**

The Arno farm team began the project by identifying the equipment and supply needs for the farm. Preparation of beds for vegetable and traditional food plants proceeded between shipments of banana, taro and breadfruit cuttings and the flurry of planting which they required. Work on other projects such as the inventorying of pesticides and development of instructional materials was carried out during lulls in the planting and on days when the weather precluded field work.

About sixty per cent of the project time was spent in hands-on work in the fields planting, digging, weeding and watering. The remaining time was dedicated to equipment repair, planning, record keeping and other projects described below.

## ACCOMPLISHMENTS

### Orientation and Inventory

The project began with a week of orientation meetings in Majuro. The technical assistant toured the Laura farm and met with the Ministers and other officials associated with the project. He also met with staff and volunteers working on the Home Gardening project through the Ministry of Social Services.

Hands-on work at the Arno farm began in the second week with tours of the community and the farm. Supplies and equipment were inventoried and the TA was briefed on the history and operations of the farm. Several immediate needs for equipment or repairs were identified and communicated to the Agriculture Chief. An inventory of equipment, supplies and materials at the Arno Farm is included in Appendix B to this document.

### Farm Plan

As there was no plan of the farm which showed the locations and extent of buildings, plantings and fields, and because mapping can be an important tool for land use planning, it was decided that a plan would be drawn up. Most of the measurements for the farm plan were taken during the first month of the project. The TA worked one-on-one with the JTPA workers to locate fields, planting beds, large trees, ditches and buildings on the farm. Beds and fields which were developed during the project period were measured and recorded by the TA and the Farm Manager near the end of the three months. The plan was drawn up by the TA with support from the R&D Division of Lands and Surveying.

### Nursery Project- Planting Taro, Banana and Breadfruit

The nurserying aspect of the project was begun when the taro and banana starts from Kosrae were sent to the Arno farm from the storage area at the Laura farm. A list of varieties planted at the Arno farm for nurserying is included in Appendix C.

### Taro

Before the taro beds were planted the large diesel tiller was used to till the area. Typically, the soil in these areas was six inches of dark gray very sandy loam over a subsoil of pink coral sand. Over the past few years coconut husks had been incorporated into the soil in some parts of the beds and the soil was noticeably more loamy in these areas. The large weed clumps were raked out of the bed and then the large tiller was used to pile the topsoil into long beds. Planting holes were made in the bed using a heavy iron pipe, the taro setts were placed in the holes with the bottom of the sett buried three to four inches deep. The holes were filled in by hand and each sett was watered using a plastic cup and a bucket. A total of 2,346 setts of *Colocasia* and *Xanthosoma* taro were planted.

### Banana

Banana plants were received in two conditions; as unsprouted eyes and as bareroot sprouted eyes with one to two feet of top growth. The unsprouted eyes were trimmed of any soft or rotten tissue and then set in two to three inch deep trenches. The trenches were

filled in, the eyes were watered and the bed was covered with coconut fronds as a moisture conserving mulch. Four hundred and thirty-seven banana eyes were planted in this way.

The bed for the sprouted banana eyes was prepared by tilling and raking to remove weeds and then making six inch deep furrows. The sprouted eyes were placed in the furrows and the soil was brought in around them. The sprouted eyes were watered in with a cup and bucket. The young banana plants, shipped without soil and with their tops untrimmed, suffered considerable stress as a result of this method of handling and planting. None of the plants died but their growth was slow. A total of 49 bananas of the Manila variety were planted as sprouted eyes.

### Breadfruit

Two hundred and ninety-five breadfruit root cuttings were planted in two beds on the Arno farm. The first bed, located south of the farmhouse, was tilled and weeded and then raked out somewhat level. The root cuttings were placed end to end in two inch deep furrows and then covered lightly with soil. Coconut fronds were laid over the bed to help retain moisture and the bed was watered by hand. Heavy rains fell two weeks after the cuttings were planted and the bed was flooded to a depth of several inches. Many of the cuttings floated out of the soil and had to be replanted. Some of the cuttings were set into the soil at an angle with one end protruding to test whether this traditional method would yield better results. To date none of the cuttings has sprouted.

The second breadfruit bed, which contains 68 cuttings of the Fokeke variety, was developed in the field west of the farmhouse. The second bed was tilled and weeds were raked out, and then the root cuttings were set into the prepared bed at about a 20° angle with four to six inches of cutting protruding from the soil. The cuttings were watered and left unmulched.

### **Pesticide Identification and Disposal Project**

When the Taiwanese agricultural aide workers departed the Arno farm they left behind a large stockpile of pesticides. The TA and Farm Manager discussed the use of the chemicals on the site and raised two arguments for not using them: the farm is intended to serve as a demonstration of sustainable farming techniques and the use of pesticides is incompatible with that goal; and, any chemicals used on the farm could soon be leached through the sandy soil into the groundwater. In addition any attempt to dispose of the chemicals on site by burying them could also result in groundwater contamination. The situation was discussed with the Agriculture Chief and it was decided to identify and inventory the chemicals and ship them to the Environmental Protection Authority in Majuro for disposal.

The pesticides were identified and placed in labeled plastic bags for shipment to Majuro. Unfortunately we were unable to complete the disposal of the pesticides before the end of the project period. A list of the pesticides at the Arno farm is include in the inventory of equipment and supplies in Appendix B.

### **Vegetable Seedling Production and Distribution**

From the Laura farm we obtained seeds of cabbage, cantaloupe, cucumber, bell pepper, eggplant, pumpkin, tomato and watermelon. The seeds were sown into plastic bag

containers which held about 750 ml of screened field soil. The pots were held in the shade house while they germinated. Two weeks after the seeds were sown heavy rains fell for several days and several of the crops sustained heavy losses as seedlings were drowned or physically damaged by the force of the rains. This event supports the argument for covering the shade house with a solid, transparent roof. It will be very difficult to reliably produce crops of seedlings on the Arno farm without an area where the seedlings can be protected better than they are at present. Appendix C contains a listing of the vegetable plants produced.

Despite the problems with the weather, we produced an adequate number of seedlings to provide plants for future seed for the farm and we were able to make some plants available to the Arno community.

The distribution aspect of the vegetable project was not as successful as it should have been. The farm is not well known throughout the atoll as a source of plant material and it is likely that many people do not have access to the farm's distribution program because of transportation problems. Some recommendations for improving this aspect of the farm project are included in the Recommendations section below.

### **Annual Seed Sowing Schedule**

We determined that in order to promote vegetable gardening we should try to have vegetable starts available to people throughout the year. We developed a schedule, contained in Appendix D, for producing vegetable seedlings on a four month cycle. The rainfall patterns were taken into account and distribution dates are scheduled to fall during the wetter months of the year.

The schedule calls for dividing the vegetables into those which are ready for transplanting into the garden in about a month and those which require more time for growth. According to this scheme, the seeds of the two groups of vegetables are sown at different times in order that they will be ready for transplanting at about the same time. This kind of production planning will facilitate distribution because community members can get garden-ready seedlings of all varieties with only one trip to the farm. In addition, having all the seedlings ready at one time will be an advantage for the Farm Manager who can distribute all varieties in each trip through the atoll's outer communities.

### **Mixed Garden Bed Development**

In order to have a garden bed in which mixed gardening could be demonstrated, we developed a bed based on the compost pit method. The bed was laid out with dimensions of eight feet by 84 feet. The site was first tilled and the large weed clumps were raked out. The topsoil layer, about six inches deep, was removed and set aside and then the coral sand subsoil was excavated to a final depth of about two feet. The sand was piled to the side of the trench. Coconut husks were laid in the bottom of the wide trench with their inner, concave surface facing up to help hold moisture. Next a layer of dead coconut fronds was laid on the husks and covered with a thick layer of breadfruit leaves and other vegetable debris. Lastly, a layer of *Vigna marina* (markinenjojo) vines about one foot thick were placed on the other vegetable debris and sea cucumbers were added. The removed topsoil was then screened and placed on top of the markinenjojo. The bed was planted with bananas interplanted with pumpkin, cucumber and canteloupe.

**Garden Pit Development Instructional Leaflet**

We made plans to go to Ine island to deliver plants from the farm to the councilmen there for distribution to the community. We recognized that we would not be able to advise individuals personally about how to prepare a bed for the plants and decided to prepare a flyer which would provide the information. The Marshallese text for the simple leaflet was written by the Farm Manager and the illustrations were done by the technical assistant. Ishamu Labin in the R&D Agriculture Division office in Majuro helped with final wording and production of the flyer. A copy of the leaflet is included in Appendix F.

**Fertilizer Usage Information**

There are over three tons of fertilizers, left by the Taiwanese aide workers, stored at the Arno farm. The chemicals were identified and inventoried and instructions for their use were compiled. The instruction sheets explain how to prepare mixes of the fertilizers for specific purposes and how to apply them. The instruction sheets are included in Appendix G.

## RECOMMENDATIONS

The following recommendations are made based on information gathered during the project period. It is our belief that implementation of these recommendations will improve the efficacy of the Replanting for Self-Reliance program.

### **Focus efforts on nutritious plants**

The vegetable distribution program is intended to promote the growing of vegetables by atoll residents. Currently, crops of low nutrient value such as eggplant and cucumbers are included in the program. In order to better address the nutritional needs of the atoll residents, the program should focus on crops such as bele, pumpkin and chili peppers (for leaves) which supply nutrients which are known to be lacking in the local diet. The bibliography to this report contains several references (Euselio; Rody; Sommers), which provide information on the nutritional values of crops. The nutritionists at the Ministry of Health and Social Services are also a valuable resource and can help identify appropriate crops.

### **Facilitate intra-atoll travel by extension agent**

The food and vegetable plant distribution programs are hampered by the inability of the extension agent/farm manager to travel between the communities of the atoll. Providing access to boats or vehicles or to fuels with which to barter for transportation will enable extension agents to improve their outreach and distribution programs.

### **Establish a policy for pesticide use**

The large stockpile of pesticides stored at the Arno farm underscores the need for a policy regarding the use of pesticides in Division of Agriculture projects. Pesticides are not generally available to the atoll residents and therefore their use on a demonstration farm is inappropriate. Use of this chemical technology also raises the very real likelihood of pesticide contamination of the local water supplies. Coarse, sandy atoll soils allow quick movement of surface water into the groundwater and contamination of a well could happen very quickly. If it is determined that pesticides are to be used on the Arno farm, they should be applied only by someone trained in pesticide safety and application.

### **Signage for the Arno farm**

The Arno farm is not well-known throughout the atoll as a source of plants. A sign at the gate should identify the farm as a public project and describe its mission. Another sign near the gate which tells when the plant distribution is scheduled would help to raise awareness of the program.

The plantings in the fields should be labeled with small signs so that community members can compare and become familiar with the varieties offered. When people become familiar with the varieties they can help to provide the Agriculture Division with information about the performance of specific varieties in home gardening situations.

**Barter plant starts for needed indigenous fertilizers**

Presently plant starts are distributed free of any charge, although they are produced at considerable cost. By asking community members to bring coconut husks, sea cucumbers, or other locally available fertilizers to the farm in exchange for their plant starts, the community can be more involved in the farm and the farm manager will get some much needed help. Such a system will help to supply the farm with needed organic material and will also raise awareness of the use of indigenous materials for enriching the soil.

**Establish a policy of mulching fields**

The current practice of planting out seedlings, trees and food plant starts without mulching them results in more water stress, more weeding and more watering than is necessary. Mulching with coconut husks and fronds or compost will improve the soil, decrease the need for irrigation and weeding and will set an example of good gardening practices.

**Establish a policy of not burning organic wastes**

The traditional burning of organic wastes in coconut plantations results in a loss of nitrogen and a decrease in the organic matter content of the soil. This practice is not appropriate for a demonstration farm where soil improvement is an important responsibility. By composting all vegetable matter, the farm will gain organic material for soil improvement and will set an example of good gardening practices.

**Stockpile organic materials**

The soil improvement projects and planting bed development projects which are ongoing on the farm require large volumes of organic material: coconut husks and fronds, markinenjojo vines, breadfruit leaves, etc. These materials are not always available in the quantities required when a project is being undertaken. By stockpiling these materials when they are available, soil improvement and composting projects could go on at all seasons.

**Plant markinenjojo (*Vigna marina*) as a cover crop**

The indigenous vine, markinenjojo is a nitrogen-fixing plant which grows well on poor, sandy soils. If the fields which are not being used were tilled and planted to markinenjojo and then tilled periodically the soil would be improved much more rapidly than it will be under the current cover of coarse clumpy grasses. The cover could be established by planting stem cuttings or seeds. Seeds could be obtained through a trade-for seedlings program, as the plant is common on the atoll and seeds can be gathered easily.

**Replace the roof on the shade house**

Heavy rains two weeks after planting took a heavy toll of vegetable seedlings during the project period, causing a loss of 50% of some varieties. A transparent acrylic or fiberglass roof will protect the seedlings heavy rains, and will also reduce leaching of the germinating soil mix. If the vegetable seedling distribution program is to become effective in the community it must be a reliable source of plants. Present conditions make it difficult

to reliably raise a crop of healthy seedlings.

**Detail equipment or crews to the Arno farm**

When equipment breaks down or is not available on the Arno farm it should be borrowed for an appropriate period of time from the Laura farm. The recent breakdown of the tiller used to weed the taro rows at the Arno farm resulted in the loss of many work hours as the weeding had to be done by hand. Similarly, assigning Laura farm employees to the Arno farm for a few days to help with projects there may allow for the most efficient use of employees.

**Require monthly reports of extension agents**

A simple report form which requires the agents to answer questions about their activities and their plans and supply needs will help greatly in the planning and budgeting process. It will also encourage pro-active thinking and planning on the part of the agents and will improve supply and equipment provisioning.



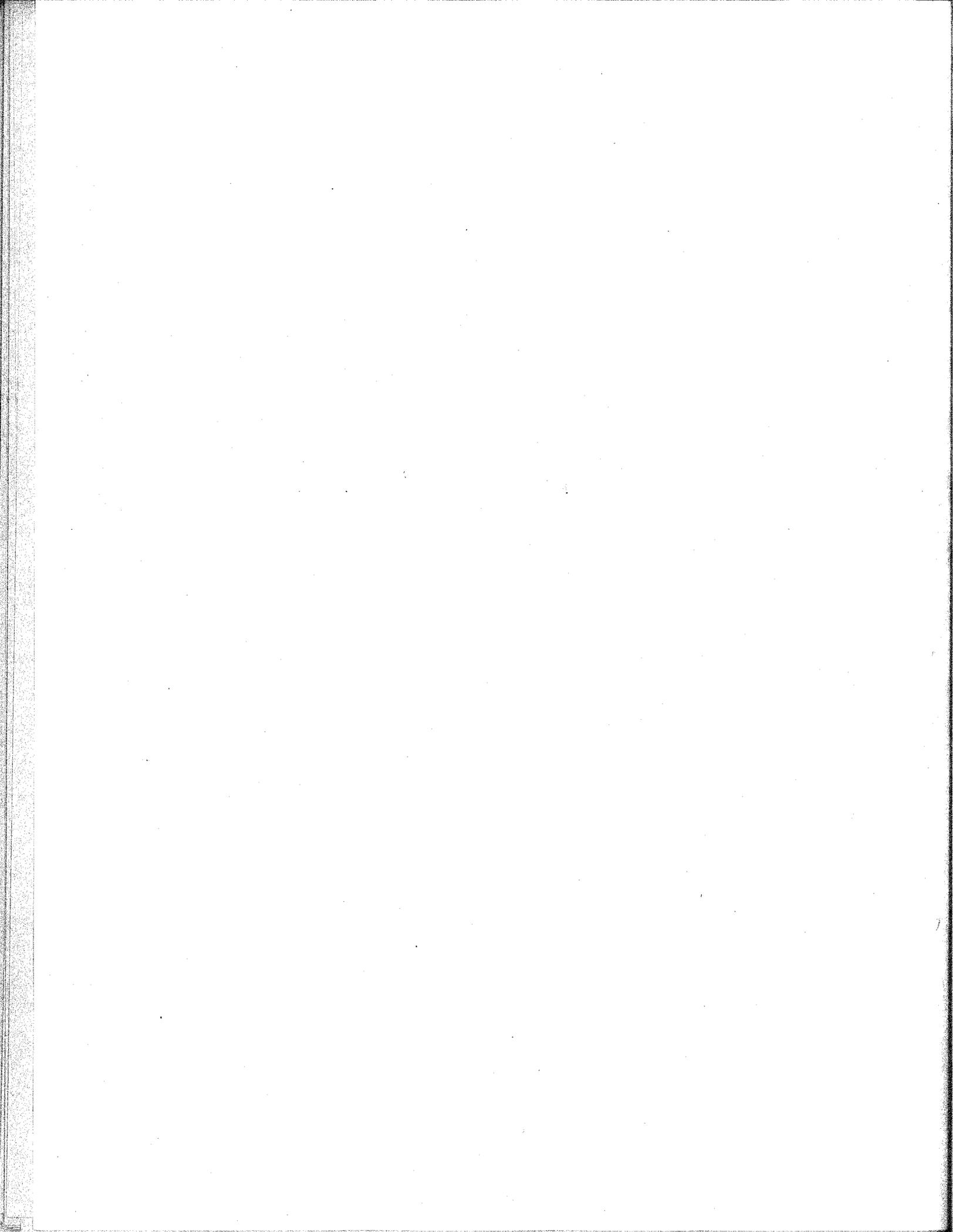
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## APPENDICES

- A. Plan of the Arno Farm
- B. Inventory of Equipment and Supplies
- C. Arno Farm Food Plants - Planting and  
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- D. Annual Schedule for Vegetable  
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- E. The Soils of the Arno Farm
- F. Instructional Flyer: How to Develop a  
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- G. Fertilizer Mixes and Applications

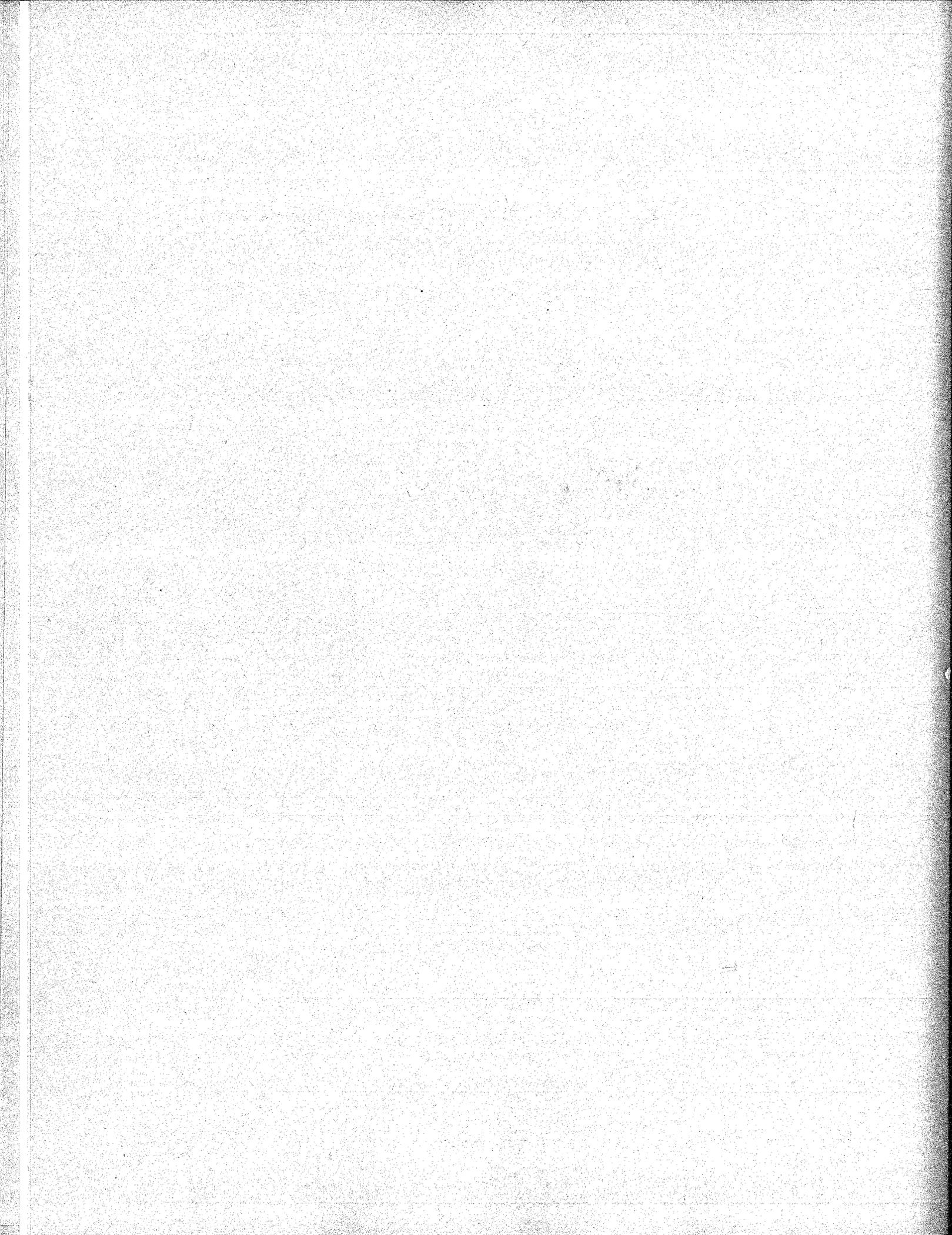


**APPENDIX A:**

**Plan of the Arno Farm**

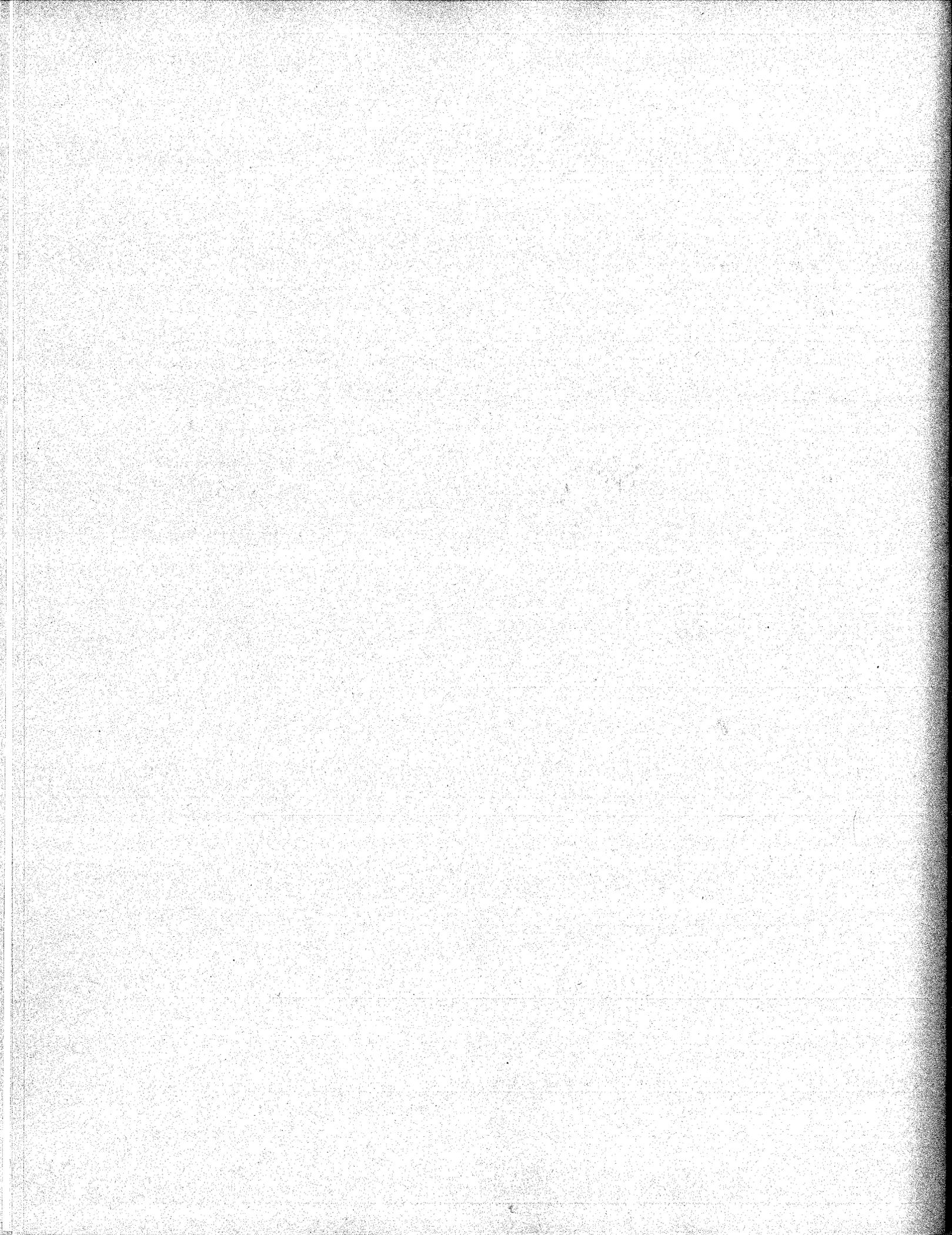






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**APPENDIX B:**  
**Inventory of Equipment, Supplies**  
**and Pesticides**



## Inventory of Equipment and Supplies on the Arno Farm September, 1993

Item	Description	Functions?	Fuel
Generator	3KW	Yes	Diesel
Tiller	large	Yes	Diesel
Tiller	small	Yes	Gasoline
Irrigation pump		No	Diesel
Utility vehicle	Toyota	No	Gasoline

Item	Description	Number	Comments
Shovels		11	
Rakes		5	
Wheelbarrow	large	2	
	small	1	
Hoes		4	
Picks		1	Also have 2 extra pick heads
Sprayer	backpack	2	
Sprayer	small	2	Need hose connectors

### Fertilizers

There are about 2900 Kilograms of fertilizer stored in the warehouse at the Arno farm. There are roughly equal amounts of the following types.

Ammonium Sulfate - "white salt" - has absorbed water and hardened.

Potassium Chloride - "red salt" - somewhat hardened

Superphosphate - "gray flour" - remains powdery and easily spreadable

### Inventory of Pesticides on the Arno Farm September, 1993

No.	Size	Form	Chemical
10	450g	85% Powder	1-Naphthyl-N-Methylcarbamate (Trade name: Sevin)
6	500g	85% Powder	1-Naphthyl-N-Methylcarbamate (Trade name: Sevin)
9	500g	75% Powder	Tetrachloro-isophthalonitrile
21	120g	80% Granules	Metaldehyde (a molluscicide)
40	100g	0.5% Powder	Rat Poison (probably warfarin type)
7	100g	45% Powder	Triphenyltin Acetate (Trade name: Brestan, a fungicide, algicide, molluscicide) QUITE TOXIC
4	500g	35% Powder	1,1 Bis (P-Chlorophenyl) 2,2,2 Trichloroethanol (Trade name: Kelthane, an acaricide)
20	250g	75% Powder	Dimethyl Ester of Tetrachloroterephthalic Acid
3	900g	65% Powder	Zinc Ethylene Bis Dithiocarbamate
6	1kg	50% Powder	Methyl 1-(Butylcarbamoyl)-2 Benzimidazole Carbate
3	1kg	19.5% Powder	2,4 Dinitro-6-Octylphenyl Crotonate; 2,6 Dinitro-4-Octylphenyl Crotonate and Nitrooctyl Phenol(principally Di-Nitro) (Trade names: Dinocap, Arathane, a fungicide and acaricide)
27	500ml	43% Liquid	2-Chloro-2,6 Diethyl-N-(Methoxymethyl) Acetanilide
5	1 liter	50% Liquid	S-(1,2 Dicarboethoxyethyl) O-O Dimethyl-Phosphorodiethoate (Trade name: Malathion, an insecticide)
4	1 liter	45% Liquid	O-Ethyl-O-P-Nitrophenylthionobenzenphosphonate
3	1 liter	44% Liquid	O,O-Dimethyl-S-(N-Methylcarbamoylmethyl) Phosphorodithioate

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**APPENDIX C:**

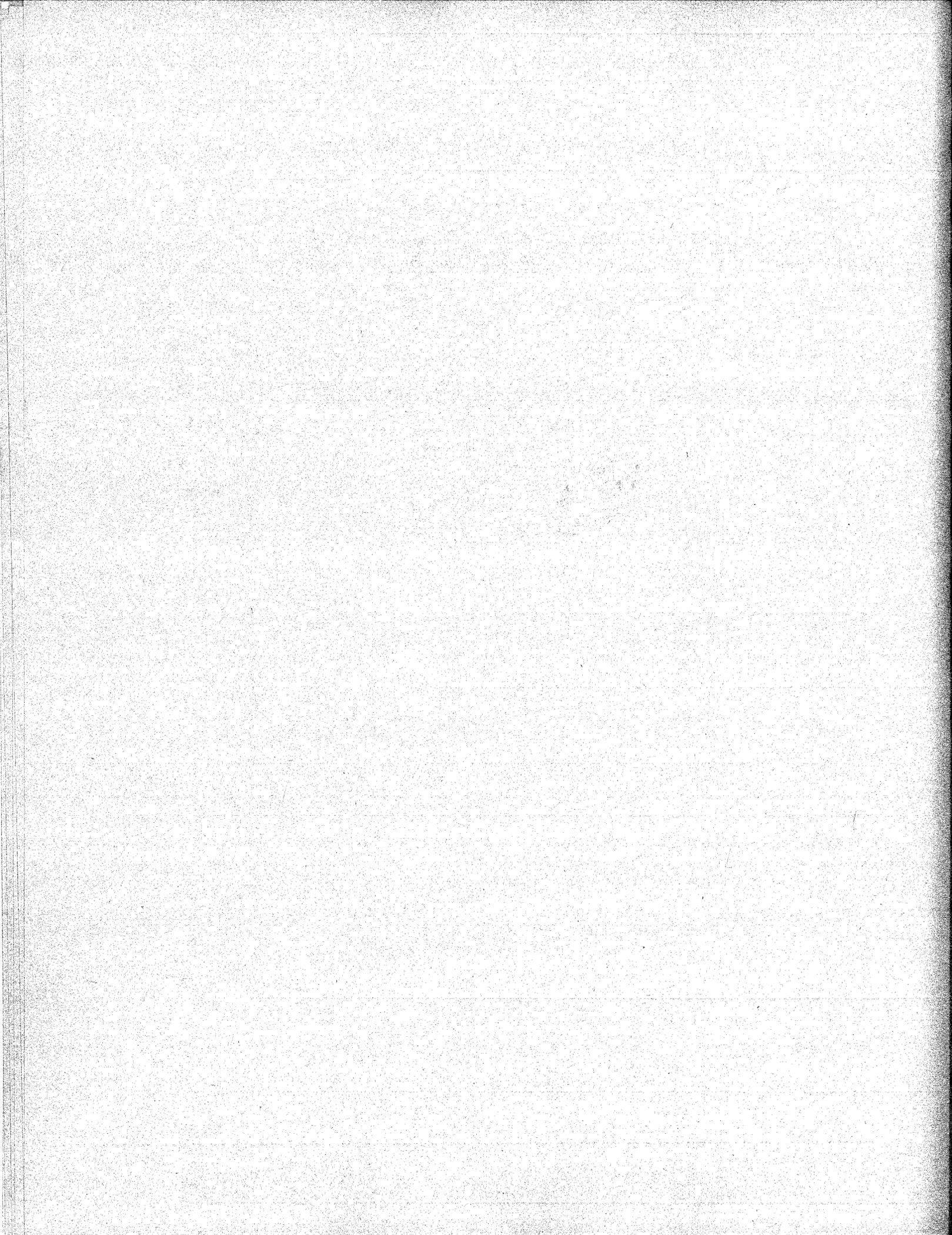
**Arno Farm Food Plants - Planting and  
Distributions: July - September 1993**



### Arno Farm Food Plants - Planting and Distributions: July - September 1993

<u>Plant</u>	<u>Number Planted</u>	<u>Number Distributed</u>
Banana "Lacatan"	437	0
Banana "Manila"	49	1
Taro ( <i>Colocasia</i> and <i>Xanthosoma</i> )	2346	25
Breadfruit	295	0
<u>Vegetables</u>		
Cabbage	60(38)*	0
Cantaloupe	100	10
Cucumber	100(55)*	20
Bell Pepper	50	0
Eggplant	50(35)*	0
Pumpkin	26	5
Tomato	50(32)*	0
Watermelon	50(39)*	0

\*Note: Heavy rains two weeks after sowing caused the loss of many seedlings. For those varieties which were most affected numbers sown are shown above with the number of surviving seedlings shown in parentheses.



**APPENDIX D:**

**Annual Schedule for Vegetable  
Plant Distribution**



## Annual Schedule for Vegetable Plant Distribution

In order to provide vegetable seedlings for distribution throughout the year, an annual schedule for sowing and distribution should be developed and followed. The vegetables which are currently part of the distribution program have been used for this schedule and the difference in their rates of growth have been considered. The vegetables have been divided into two groups; Group I includes the more slowly developing types such as tomato, bell pepper, watermelon and cabbage, and Group II includes those types which more quickly reach transplanting size such as pumpkin, cantaloupe and cucumbers.

The schedule shown below suggests that Group I seeds be sown in the latter half of January and that Group II seeds be sown in the first half of February. The seedlings produced will be ready for distribution in the first part of March. This six-week seedling production and distribution cycle can be repeated three times or more each year in order to encourage and support year-round vegetable gardening.

Sowing and Distribution Schedule

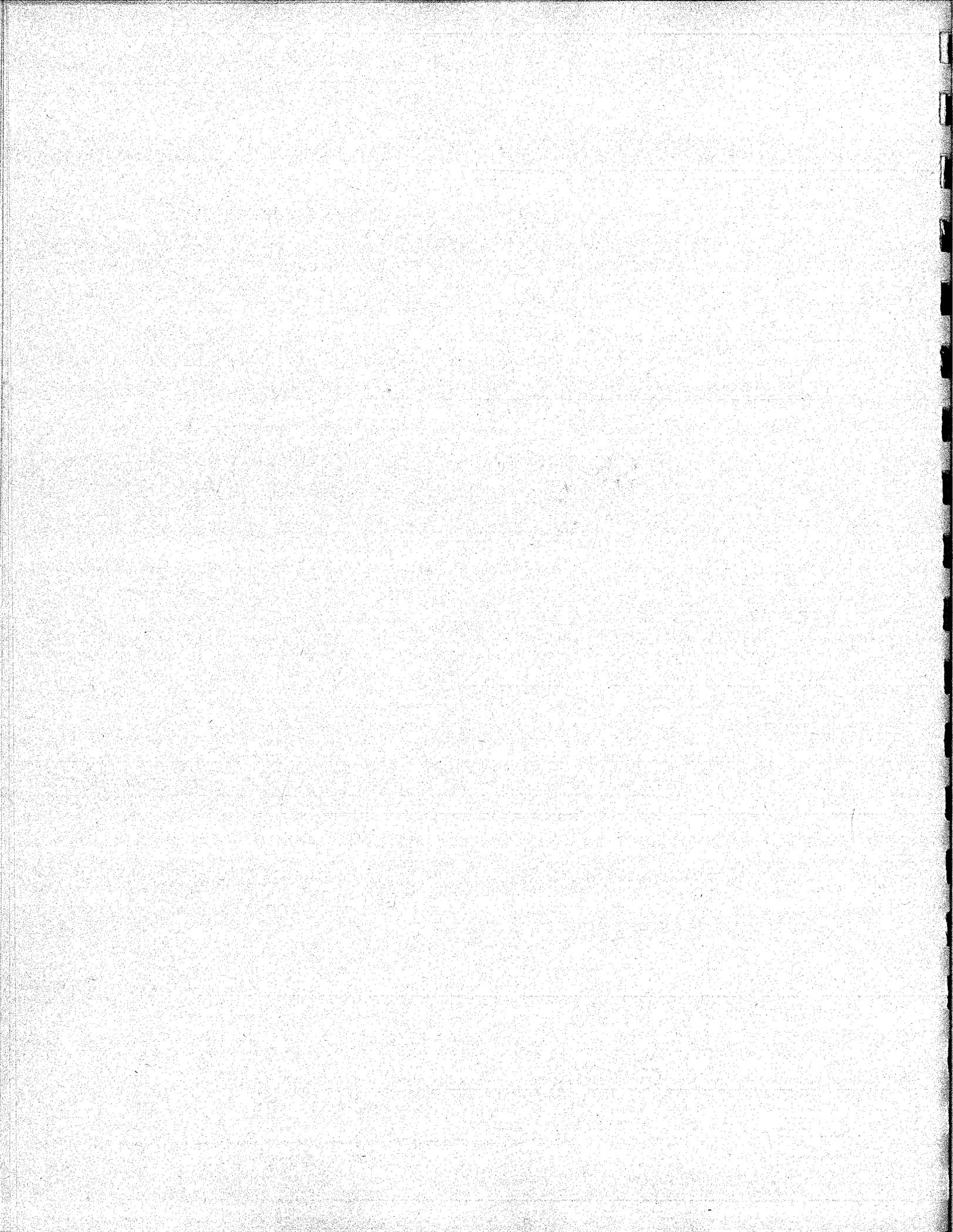
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Sow Group I												
Sow Group II												
Distribute												
Sow Group I												
Sow Group II												
Distribute												
Sow Group I												
Sow Group II												
Distribute												



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**APPENDIX E:**

**The Soils of the Arno Farm**



## The Soils of the Arno Farm

According to the recent USDA Soil Conservation Survey, (Laredo, 1989) the original soils of the Arno farm are of the Ngedebus series, primarily the Ngedebus loamy sand, dark surface phase. These soils tend to be excessively well drained and have a moderate water capacity (0.08-0.10 cm/cm) in the upper horizon. Soil reaction is from slightly acid to alkaline values as high as pH 8.4. Organic matter content is low, from 10 -15%. Typically about six inches of these darker, richer soils lay over a subsoil of nearly sterile light colored coral sand.

The soils on the farm vary from those on the eastern side which have been cultivated and improved by the addition of organic matter, to those on the western end which are much poorer and more gravelly and support a broken cover of coarse grasses, *Vigna marina* (Markinenjojo), and native shrubs.

Soils such as those at the Arno farm, fast draining, sandy soils low in organic matter, tend to be low in nutrients, particularly nitrogen and potassium. As Laredo recommends, the best management strategies for these soils are those which maintain or increase the organic matter content. Mulching, green manuring and composting should be increased in farm practices to improve the soil. The use of nitrogen-fixing plants for cover cropping and green manures can help to improve the level of available nitrogen. Potassium levels in the soil can be raised by burying coconut husks and by using them as a mulch wherever possible. When husks are burned, the ashes should be returned to the field to replace potassium.

Minerals such as iron, copper, zinc and manganese also tend to be lacking in atoll soils such as those at the Arno farm. Chelated micronutrients or foliar sprays of mineral salts can be used to supply these elements but such practices are not available to most atoll residents and may not be appropriate for a demonstration farm. Marine fertilizers, available on the atolls, might also be used as a source of micronutrients. Seaweed, fish scraps and waste and sea cucumbers should be used to the greatest extent possible.



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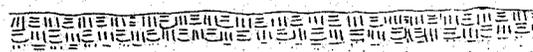
**APPENDIX F:**

**Instructional Flyer: How to Develop a Garden Pit**

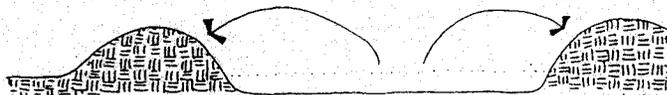


KILEN KEBOJE RON IM WEWEN KALIBINI INE IN  
BINANA EO.

1. LAJRAK IN BWIDEJ KILMEJ IM BWIDEJ  
MOJ EO.

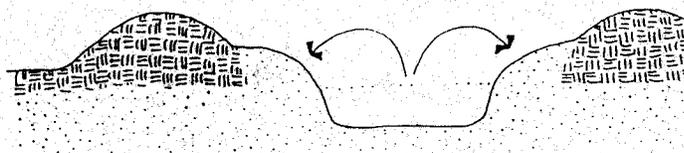


2. KILEN JINO KIBIJI RO EO.



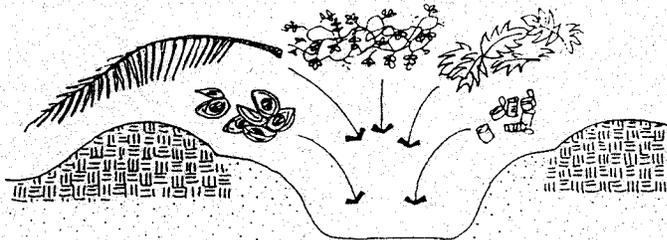
3. KILEN KIBIJI RO EO EM EN EINWOT IN:

- Bwidej kilmej eo en bed turun wot ron eo.
- Mwilalin in ron eo en 2'.
- Aitokan ron eo en 2'.
- Debakkak in ron eo en 2'.

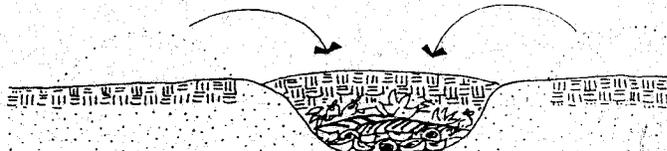


4. MENOKNOK KO REN BED ILOAN RON EO:

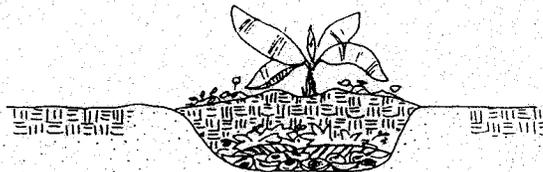
- Lal-tata bweo in waini kab cans ko rejela lejjo.
- Lon-tok kimej in ni.
- Lon-tok jidik aolep kinds menoknok mor.
- Lon-tok bar jidik markinjojo, marbele kab marlap.
- Lon-tata kibwe in bao im pigs. Em bar me men in mour in lojet ko einwot jibenben im majkedel.



5. KEJEBLAK BWIDEJ KILMEJ NON LOAN RON  
EO.



6. KALIBINI INE IN BINANA EO EM EN EINWOT  
IN ILO PIJA IN ILAL.



ENIN EJ AOLEPEN KILEN IM WEWEN KALIB BINANA.



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**APPENDIX G:**  
**Fertilizer Mixes and Applications**



## Fertilizer Mixes and Application

There are three types of fertilizers stored on the farm:

- **White** (looks like salt) - the nitrogen fertilizer  
21% Nitrogen, soluble in water, probably ammonium sulfate
- **Gray** (looks like flour) - the phosphorous fertilizer  
18% phosphate, not soluble in water, probably superphosphate
- **Red** (looks like red salt) - the potassium fertilizer  
60% potassium, soluble in water, probably potassium chloride

While the fertilizers can be used separately, they are probably best used as a mix. A good **general mix** for the Arno farm soils is:

2 parts (handfuls or cups, etc.) white fertilizer  
1 part gray fertilizer  
2 parts red fertilizer

Mix the three fertilizers together well and apply the mix at the rate of one handful per small tree, two handfuls for trees over 5 feet tall or, for crops in rows, one handful for each 5 to 10 feet of row.

**For composting**, the following mix will speed the breakdown of vegetative material such as leaves, coconut husks, etc.:

3 parts white fertilizer  
1 part gray fertilizer  
1 part red fertilizer

Mix the three fertilizers together well and apply evenly over the material to be composted, one handful for every three wheelbarrows of green manure or one handful for each wheelbarrow load of coconut husks.

• These mixes can be made up in any quantity, from a few handfuls to a wheelbarrow full. However, the red and white fertilizers will absorb water and harden in time so it is probably best to mix only what can be used in a day.

**For feeding transplants and seedlings** the white and red fertilizers can be dissolved in water. For five gallons of water add:

1/4 cup white fertilizer  
1/4 cup red fertilizer

Mix the fertilizers well with the water and let sit for at least ten minutes to dissolve. The fertilizer solution can be applied with a watering can or with a cup. Apply the solution at the rate of one cup per vegetable transplant or one gallon per transplanted tree or large plant. For seedlings in pots, apply the solution using a watering can. If you put more than 1/4 cup of each fertilizer in five gallons of water you may burn the plants.

There is also a supply of iron sulfate fertilizer in the warehouse. It is a dark brown powder, stored in white plastic jars. Iron is often lacking in atoll soils and plants show a lack of iron by getting yellow between the veins. Lime trees are especially susceptible to low iron. This **iron fertilizer** is intended to be applied to the leaves of the plants as follows:

Mix 2 teaspoons or 1/2 tablespoon of iron sulfate powder in one gallon of water.

Put the mixture in a sprayer and apply to the leaves of the plants. Spray them enough that the mix runs off the leaves.

**Remember, fertilizers can move through the ground and into the water in your wells so don't overuse them!**

