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1967 BIKINI RADIOLOGICAL RESURVEY--MARSHALLS

AGRICULTURE REPORT

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An agricultural survey was completed by the writer along with the AEC survey team consisting of personnel from the University of Washington, USN Radiological Defense Laboratory, AEC, N.Y. Health and Safety Laboratory, Division of Operational Safety and the Division of Biology and Medicine on the former nuclear testing ground of Bikini Atoll, during the period of April 23 to May 7, 1967. The primary purpose of the survey was to determine the residual radioactivity on the islands. The radioactivity from the many nuclear test shots conducted in Bikini will affect the final decision to repatriate the former Bikini people to their original homes. The agricultural survey considered the physical and ecological characteristics, with general recommendations for reclamation of the islands towards complete rehabilitation of the atoll. It can be said that Bikini, like most all coralline atolls, affords an environment not harsh, but marked by a lack of diversity----agriculture is one of copra production and at a subsistence level. Thus, the major emphasis should be on the cultivation of coconuts and other local subsistence crops which are suited to these conditions.

As the radiation levels on the atoll decrease to a point safe for human habitation, preparations toward the repatriation of the Bikini people now residing on Kili Island should be seriously considered. It may well be, according to final decisions from the administering authorities and the Atomic Energy Commission, that Bikini may be granted a safe bill of health for

the return of the former peoples in coming years. While it is too soon to definitely state when the Bikinians may be returned, preparations and planning should start as soon as possible.

Central to the purpose of the rehabilitation of the entire atoll will be the provision of physical facilities, infrastrutures, and the agricultural reclamation of the lands now given to the encroachment of much wild vegetation. Planning of the entire rehabilitation program is of prime importance and should include plans for sites for villages, community facilities, roadways, coconut groves, subsistence crop areas, etc.

The Bikini situation, a stepchild of a former Navy Administration, may well turn out to produce more adverse problems for the Trust Territory Government if serious and liberal planning is not directed to an early and intelligent repatriation of the Bikinians. Few things could be more productive of controversy than the unwelcome dislocation of life experienced by the Bikini people in deference to the testing of destructive weapons of war. At present much resentment and dissatisfaction are voiced by the Bikini people, who now reside on the lagoon-less island of Kili. Their relocation from an atoll with an abundant resource of fish in its large lagoon to a tiny island which is unaccessible by small boats six months of the year because of heavy seas does not help to assuage this resentment. Frequent requests are made by the Bikinians to return to their former homes and most of them earnestly believe that their return will be soon. As a consequence these people

have no desire to exert their energies in improving the agricultural productivity of Kili, even with frequent clarification of the permanency of their residence on Kili Island have an adamantine belief.

Present Conditions of Bikini Atoll

Bikini Atoll, consisting of 36 islands with a land area of 2.32 square miles, is situated in the northern Marshalls 11 degrees 29 minutes to 11 degrees 43 minutes North Latitude, 165 degrees 11 minutes to 165 degrees 34 minutes East Longitude. The lagoon extends over an area of 229 square miles. The soils of the islands are of the lithosol and regosol group, and in terms of profile they consist of 3 horizons----A_1 (zone of incorporated organic matter), A_3 (transitional) the horizon passing directly into the relatively unaltered parent material, the C horizon. The annual rainfall is much lower than the southern atolls, but considered adequate for cultivation of plants siutable to atolls, and perhaps ranges from 60 to 90 inches per year.

As a result of damage incurred by the series of nuclear test explosions, the vegetation is atypical of other atolls---- all of the islands have little or no coconuts and pandanus and are covered with thick stands of Scaevola, Messerschmidia, Cordia, Pisonia, etc. Other subsistence crops are absent from the islands. Although two islands, Bokbata and Bokanejen on the

northwest end of the atoll, were reduced to mere sand dunes, no other visible damages or profound mutations to the flora and fauna are evident.

Sea life in the lagoon is plentiful and shows no sign of adverse effects from the nuclear detonations in the atoll. The absence of man for almost two decades has forced the increase of reef fish in the lagoon in substantial numbers. Many schools of reef fish, turtles, shell fish, and pelagic fish are commonly seen in the lagoon and along the shore lines.

Bikini Island

Bikini Island, the major population center, is the largest among the 36 islands making up the atoll and is situated on the northeast corner of the atoll. Most of the island is now covered with thick stands of wild vegetation that cause some difficulty to traverse the interior. The strand vegetation consists of Scaevola, Messerschmidia, and some Guettarda, with Pluchea, Dodonea, Leucaena, Cordia, Pisonia, Morinda, and Hernandia making up the interior vegetation. Thick growth of Clerodendrum are found in the southern portion of the island. Ground cover consists principally of Fimbristylis, Lepturus, Triumfetta, Ipomoa, Boerhaavia, and Portuluca.

The nuclear blasts have destroyed the former coconut groves and only a few subsistence crops, mainly pandanus and few arrowroot, Tacca leontopetaloides, are found growing among the wild vegetation. The few coconuts found in the interior of the island

range from 4 to 12 years of age and are not of the best quality. Their yields are low and individual nut size is small. No other subsistence crops----taro, breadfruit, papaya, banana----are found on the island.

The strand vegetation consists of Scaevola, Messerschimidia, some Guettarda where the soil is not fertile. Within the interior where Cordia and Pisonia forests have contributed to the organic matter content, the soil is comparatively fertile. The island, which is approximately 2.2 miles long and 0.6 miles at the widest point, provides some 400 acres that can be utilized for crop development.

The remains of the facilities used during the nuclear test period include many wooden buildings, some concrete bunkers and two steel towers about 65 to 75 feet in height.

Enyu Island

Enyu Island is the second largest island in the atoll. It is situated on the southeast corner of the atoll; its length is approximately 9,000 feet and 1,800 feet at the broadest point. A 4,000 foot asphalt runway extends over the southeastern leg of the island. Like the other islands, the ubiquitous Scaevola and Messerschmidia make up the strand vegetation. Similar types of vegetation found on Bikini cover the interior of the island. The few coconuts that are found on the island are not of the best quality and yields are poor. The soil is not unlike that found at Bikini Island. The estimated 265 acres of land area

can support productive groves of coconut and subsistence crops.

There are three towers----a 300-foot steel tower at the south point, another 100-foot tower with two large radar antennae to the north, and a 75-foot wooden tower on the northern tip. One large aluminum warehouse building is located on the southeast edge toward the ocean; other structures of wooden construction are scattered throughout the island. Two large piers are located on the lagoon shore in the middle of the island.

Nam Island

Nam Island is situated on the northwest corner of the atoll and is the third largest island----approximately 3,600 feet long and 3,000 feet wide. The estimated 122 acres now host large trees of Messerschmidia. Large open areas within the inland are covered by Fimbristylis grass and Ipomoa vines. The soil is relatively fertile as evidenced by the lush growth of the vegetation. Many birds (noddies, boobies, terns and turnstones) nest among the shrubs and grasses to contribute much guano to the soil composition. On the southwest corner of the island, where much erosion has occurred, due to wave action or probably from a nuclear explosion that was detonated on a nearby island, the organic matter content in the soil profile runs as much as 18 inches in depth.

Two large damaged concrete bunkers are located on that island.

Bokantuak-Iomeleñ-Rojkere-Eonjebi Islands

The four islands are situated between Bikini and Enyu islands along the eastern portion of the atoll. They are all tiny islands, quite low and subjected to frequent inundation by high seas. The soil contains little organic matter and is elemental coral and sand. Large coral slabs protrude from the ground in many places. Sparse growths of Messerschmidia, Scaevola and Suriana are the principal types of vegetation on these islands; ground cover is mostly Lepturus and Triumfetta.

A large population of seabirds, noddies and fairy terns, resides on the islands; many nests are found throughout the shrubbery and grasses.

Aerokoj-Eneman Complex

This two-mile chain of narrow islands is found nine miles west of Enyu Island and consists of five islands----Aerokojkoj, Aerokoj, Bikdirin, Dredre and Eneman----all united by partly eroded causeways. The two eastern islands, about a mile in length, were used as a campsite for AEC personnel during the nuclear tests. A small runway and old buildings of the compound not now in use are toward the north end of these islands.

The soil is relatively fertile and many thick stands of vegetation in lush growth cover these two islands. The principal types of plants are Scaevola, Messerschmidia and Pluchea with ground cover of Triumfetta and Fimbristylis. Coconut

seedlings growing around the camp installation are in fair growth; the few that are bearing fruit have large fruit bunches, a fair indication that coconut palms will grow well on this end of the chain.

A very large concrete building is located on the south end of Aerokojkoj.

The western islands are much less suitable for plant growth due to their drier condition and infertile soils. Much coral rock is found on the islands. The vegetation consists of Scaevola, Messerschmidia, Pluchea, Fimbristylis, Ipomoa and Triumfetta. A 200 foot steel tower is found on Eninman Island along with many concrete bunkers used to house and support equipment and instruments during the nuclear tests.

There are several tidal pools in low depressions on Dredre and Bikdrin Islands in which large mullets and milk fish are found.

Large members of seabirds of several species use the island as refuge.

Enidrik, Lukoj and Jelete Islands

Enidrik Island is situated a mile west of Eneman Island; its length is about 7,000 feet and provides about 60 acres of land area capable of crop production. Much of the island is now covered with thickly-growing vegetation of Scaevola, Messerschmidia, Guettarda, Cordia, and Pisonia. Ground cover is made up of Lepturus, Fimbristylis, Ipomoa, and Triumfetta. The

sandy soil is relatively high in organic matter content where Cordia and Pisonia are found toward the central portion of the island. Several pandanus trees and a single coconut seedling were found.

Lukoj and Jelete islands lie 3.5 miles west of Enidrik Island. Lukoj, the larger of the two islands, is approximately 2,000 feet long and 600 feet wide. Its perimeter is fringed with many coral rocks extending as far as 100 feet inland from the shoreline, and Scaevola and Messerschmidia are the principal plants surrounding the island. Boerhaavia, Portulaca, Lepturus and Ipomoa make up the ground cover. A mixed stand of Pisonia, Cordia, Guettarda and Morinda in the interior hosts hundreds of seabirds and coconut crabs. Many nests and fledglings of frigate birds, fairy terns, noddies and boobies were found throughout the island. As a result of accumulation of bird guano and vegetation, vast amounts of organic matter have been added to the coral soil.

Jelete Island is, except for its smaller size, very similar to Lukoj. It also hosts a large population of seabirds.

Oroken-Bokaetokan-Bokdrolul Islands

These three islands are situated on the southwest corner of the atoll. Strand vegetation of Scaevola and Messerschmidia encircle the islands and much of the shoreline is covered with large numbers of coral rocks thrown up from the sea. All three of these small islands host thousands of seabirds which nest among the Pisonia forest in the interior. Many nests and young

fledglings were found. Much accumulation of organic matter has taken place from birds droppings and plant foliage---- the rich organic matter extends to depths of as much as 18 inches.

Yuroj-Aomurik-Aomen Islands

Yuroj, Aomurik and Aomen islands form a chain connected by causeways on the north side of the atoll between Bikini and Namu islands. They are very narrow and frequently inumdated by high seas. Large coral slabs and bed rocks protrude through the soil surface in many areas, especially on Aomen Island. Aomurik and Yuroj to the west of Aomen are much higher and are found with undulating sand dunes along their lengths. Tidal pools, several feet deep, are scattered in several places on these islands where low depressions exist; reef fish of several species are found living in them.

Sparse growths of Scaevola and Messerschmidia are found throughout the island.

The destruction of concrete installations and the eroded condition of the islands, suggest that the nuclear explosions were responsible for the denuding of the coconut groves and surface soils.

One large concrete building is situated on the eastern tip of Aomen Island; several concrete bunkers are located on Romurik and Yuroj islands.

Initial Planning

The successful repatriation of the displaced Bikinians from Kili Island to their former atoll should be soundly grounded in a well-planned program to consider all facets for the well-being and safety of the people should Bikini be declared safe for permanent habitation. Initially, master-planning of the return of these people is paramount. The master plan should, with the inclusion of planning for village sites, community facilities, roadways, coconut groves and subsistence crop sites, delineate the method and resources for complete rehabilitation of the atoll. The planning should include the voice of the Bikini leaders to lend suggestions and ideas for final approval and clarification.

Since some changes have occurred in the topography and vegetation of the islands, boundaries of wetos (landholdings) must be clearly redefined to the satisfaction of all the people involved. Cadestrals, coconut palms, tirose (Pseuderanthemum) which are frequently used to mark boundaries, have been completely obliterated by the nuclear explosions and these must be re-installed before any sort of rehabilitation can begin.

While it is too soon to say when the atoll will become safe for human habitation, steps should be taken to reclaim the lands that are now subjected to growth of wild vegetation and replant them with agricultural crops in order that the returning people will be able to subsist and earn a livelihood from the

land. Copra production, to which these coral atolls are well suited, will require seven to eight years from initial planting to production of fruits----should repatriation take place within a decade, the islands will enable the inhabitants to become self-sufficient at that time only if agricultural rehabilitation of the atoll begins as soon as possible.

On the other hand, if steps for early completion of agricultural rehabilitation are not undertaken before the return of the Bikinians, the U.S. Government will be required to heavily subsidize the livelihood of the islanders until such a time as agricultural crops planted after their return reach maturity. A welfare and relief program, running into hundreds of thousands of dollars, exceeding the cost of a proper rehabilitation program, will have to be adopted over the years until the islands become self-sufficient. At present the absence of coconut groves and subsistence crops on these islands would make it impossible for inhabitants to eke out a livelihood, notwithstanding the vast amounts of sea life available in the lagoon and sea.

Agricultural Development

Agricultural development of the atoll should be centered towards complete rehabilitation of all the islands suited to crop cultivation. Subsistence crops of breadfruit, pandanus, dwarf coconuts should be added in the planting program also.

Other short-term crops such as banana, papaya, arrowroot, taro, sweet potato and vegetables can be propagated later.

The islands suited to crop production are Bikini, Enyu, Nam, Enidrik, Aerokoj and Aerokojkoj. The total acreage, less areas for village sites and community facilities, is 950 acres. The other islands not capable of supporting any agricultural crops are to be considered as wild-life sanctuaries----namely, Lukoj, Jelete, Oroken, Bokaetokan and Bokdrolul. These islands as refuge for seabirds, turtles (Chelonia mydas), and coconut crabs (Birgus latro), will insure the perpetuation of these species for continuous utilization by the islanders.

Reclamation of the islands should start with brushing of all wild growth with the exception of the strand vegetation to provide windbreaks on both the ocean and lagoon shores. It is advisable that rehabilitation work begin on Enyu Island, where the existing airfield may be used by aircraft to support the work crews in the initial stages. The existing buildings which can be used as housing also make it favorable for starting on this island.

All brush should be retained for later use as compost in planting hills of the coconut seedlings since no other compost materials are available on the islands. None of the brush, including heavy brush and trunks, should be burned or destroyed. The use of bulldozers and other heavy equipment will expedite clearing of the thick vegetation, for without their use clearing by manual labor will be much too slow and costly. An LCU

landing craft will also be required to transport these machinery within the atoll. This equipment, if not available through the Trust Territory Government, should be acquired from the Kwajalein Test Site or its contracting firms on a rental basis.

Cordia trees found in abundance within the interior of the islands should be utilized for furniture and handicraft manufacture or possibly for export to other countries.

With the clearing of the vegetation all towers, bunkers, and buildings, with the exception of structures that can be fully utilized, should be razed or dismantled to prevent the danger of the collapse of these structures. The high, rusting steel towers on Bikini, Enyu and Eneman are definite hazards to human life.

As the lands are cleared of all vegetation, planting hills are to be spaced, marked, and dug according to recommended specifications. Acceptable seednuts will be imported from other atolls (preferably from the Yap coconut plantings in Dalap Island, Majuro; and Jabor Island, Jaluit) in sufficient numbers to provide the 950 acres with the necessary seedlings.

Planting pits (3 ft x 3 ft x 3 ft) should be filled with the residue of the cleared vegetation; then selected seedlings transplanted as they become ready.

After replanting of the islands, frequent maintenance of the groves will be necessary to control competition of underbrush with the coconut seedlings. Regular brushing at least

three times a year for the first four years is necessary to provide favorable conditions for the earliest productivity. Adequate care and fertilization will enable seedlings to grow beyond the dangers of later encroachment by the wild vegetation.

Subsistence crops of breadfruit, pandanus, dwarf coconuts should also be planted at this time along the lagoon shore, roadways and village sites. Breadfruit varieties of bukdrol, betaktak, mejwan and metetet should be included in the plantings to take advantage of the diversity in fruit types as well as the extension of the fruiting season to which each variety exhibits an early or late bearing habit. Dwarf coconuts as a good source for toddy (jakaru) and drinking nuts in addition to an aesthetic value as landscape plants will also replace tall coconuts as a drinking nut source to fully utulize the tall trees for copra production. The many varieties of edible pandanus should also be planted throughout the village sites.

In time other crops such as anana, papaya, limes, and the hardier vegetables should be planted.

As the atoll becomes suitable for human habitation and the coconuts are in their early stages of bearing, copra driers (small Marshallese types) should be provided to all copra producers as a measure to process high-quality copra for, as is common throughout the Marshalls, lack of adequate types of copra driers leads to copra of inferior quality.

Copra warehouses should also be provided on the main islands in order that processed copra may be stored adequately and thereby promote constant processing of copra. A warehouse would also provide a favorable situation toward establishing a copra farmers' cooperative to take advantage of volume purchase of trade goods to extend over longer durations and thereby relinquish the heavy dependancy on erratic field trip service. A cooperative would contribute heavily to a steady production of copra unlike the present trend in concentrated production before the arrival of field trip ships.

The Cost of Agricultural Development in Bikini

The estimated cost of such an agricultural development program as outlined above will be in the realm of $165,000 over the four years expected for completion and maintenance. This is to say that it will cost approximately $174 to rehabilitate one acre of land, by far not a very unreasonable cost. This figure is a conservative one and does not include all the costs of logistic support and other undetermined expenses.

A large portion of the cost would be pre-empted by labor. Heavy equipment and power tools would greatly hasten work accomplishments, but the better part of the time would be required in digging of planting pits for each seedling----approximately 52,000 planting pits are required. Forty-four laborers, including three equipment operators and a mechanic, would be required to complete the replanting in one calender year (210 working days).

Maintenance of the groves would require ten men over the four-year period following. The personnel involved in the rehabilitation work should be housed in existing buildings which require little refurbishing or in temporary quarters constructed near work sites. Preference in hiring of Bikinians should be regarded in the light that their closer ties would evoke greater work accomplishments. To go further, utilization of Peace Corps Volunteers may be the answer to reduce the labor costs.

Other costs as listed in Table I include fertilizers, seednuts, POL, equipment rental, subsistence, transportation, tools, supplies, etc.

Cooperative Research Programs

The complete agricultural rehabilitation of Bikini Atoll presents a rare opportunity for the Trust Territory to conduct research on agricultural crops under atoll conditions. Taking advantage of the opportunity to test and evaluate improved cultivation of coconut and subsistence crops would be a boon to atoll development work. At present all recommendation for planting procedure adopted in the Trust Territory are the result of research findings of other countries with differing climatic and environmental conditions, e.g., Rangiroa, the Philippines, Ceylon, Africa, etc.

Investigations of fertilization (both macro and micro-nutrients), cover crops (legumes----Vigna, Canavalia; other atoll vegetation----Wedelia, Ipomoa), intercropping with banana and papaya, effects of grove maintenance, etc., are needed. Physiological investigations of foliar analysis to determine an index for fertilizer requirements in coconut groves affords a project of real benefits. Also the adoption of chemical weedicides in the maintenance of groves, which at present are laboriously brushed by manual labor, may well add much to the proper maintenance of groves. Studies in the culture of other tropical crops, which in many respects have only been slightly investigated, should also be included in the program.

No doubt, a research program of such a scope would require considerable financing and it is hardly likely that the Trust Territory Government would be able to direct such amounts toward an intensive research program. As suggested by Dr. Edward E. Held, Officer in Charge of the 1967 Bikini Radiological Resurvey, a cooperative type of research program between the Trust Territory and other research institutions, such as the East-West Center, the University of Hawaii, or other agencies capable of funding and providing the technical resources required in such a program may be initiated to derive mutual benefits. The possibility of grants from organizations, such as AEC, the Pacific Science Board of the National Research Council, the National Science Foundation, Office of Naval Research, etc., should be earnestly looked into. Vital to the

realization of atoll research with agricultural crops is sufficient funding; only through a persistent and well-thought out formulation to generate interest will the agencies capable of financing such research justify allocation of the necessary grants.

Summary and Conclusion

By way of summary, Bikini Atoll was surveyed by the 1967 Bikini Radiological Resurvey team. The many islands were thickly vegetated with wild plants in most areas. Few coconuts exist on these islands; few or no subsistence crops are found on them. While a small part of the atoll was damaged by the nuclear explosions, the atoll as a whole could support coconut groves and subsistence crops.

The lagoon has large schools of fish capable of providing the former Bikini people with an extended supply of sustenance. Seabirds are also found in large numbers throughout the atoll.

In order for the atoll to become fully self-supporting when the Bikinians are repatriated, an early agricultural rehabilitation program is recommended. The method of rehabilitation is clearly spelled out to expedite the development of the islands.

Since the coconut groves and subsistence crops would be started under almost-virgin conditions, it would be advantageous to combine the rehabilitation with an intensive research program on atoll crops. A cooperative program with other agencies or research institutions is suggested to lessen the financial burden of the Trust Territory Government in undertaking such a program.

With the Trust Territory annual budget already spread thin in other areas of endeavor, grants from research foundations may well be the answer to finance the research program and this avenue of funding should be thoroughly investigated.

Yet if only for pressing home a point, the profound implications and the moral obligation of the U.S. government to fully rehabilitate the atoll damaged by the testing of nuclear devices, liberal and well-planned efforts tailored to the future return of the Bikinians should commence at the earliest possible time. Not only is the complete rehabilitation of Bikini by the U.S. justified in the eyes of world opinion, a responsibility remains to redress an injustice to a handful of displaced poeple.

TABLE I

COST OF BIKINI AGRICULTURAL REHABILITATION PROGRAM

	Item	Cost
1.	Labor: 40 laborers at 50¢/hr for 210 working days	$ 33,600
	3 equipment operators; 1 mechanic at 70¢/hr	4,700
	Maintenance of groves (four year period) 10 laborers at 50¢/hr	33,600
2.	Heavy Equipment:	
	a. Rental of two crawler-type tractor w/bulldozer blades	4,000
	b. Rental of front end loader	1,000
	c. Rental of LCU landing craft	1,500
3.	Seednuts: 104,500 seeds required at 5¢	5,300
4.	Fertilizer: 205 tons at $100/T FOB Majuro	20,500
5.	Subsistence	30,000
6.	POL	4,000
7.	Lagoon Transportation (Boats and Outboard Motors)	3,000
8.	Housing: Construction of Temporary Quarters	10,000
9.	Personnel Transportation	5,000
10.	Tools and Supplies	3,800
11.	Miscellaneous	5,000
	TOTAL	$ 165,000