OPERATION RANCH HAND

The Air Force and Herbicides in Southeast Asia 1961–1971

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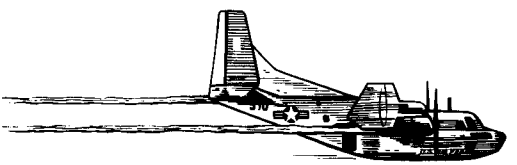

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Foreword

Since the dawn of powered flight, there has been debate about the uses of aviation in war. The air weapon could be, and has been, used for a variety of missions: to gain control of the skies, to bomb an enemy's population or war-making resources, to support armies and navies in battle, to interdict the flow of men and materiel to the battlefield, for observation, reconnaissance, the gathering of intelligence, to transport men and supplies, and for virtually every other aspect of modern combat.

One of aviation's more unusual military applications occurred in Southeast Asia, where American and Vietnamese planes sprayed large areas of Vietnam and Laos with herbicides in an effort to deny cover and concealment to the enemy, and to destroy his food supply.

Herbicides, or weed-killing chemicals, had long been used in American agriculture. After World War I, the military of various nations realized their potential for war and developed techniques to use them. Although the Italians had used lethal chemicals delivered from the air in Abyssinia in 1936, the Allies and Axis in World War II abstained from using the weapon either because of legal restrictions, or to avoid retaliation in kind. During the early 1950s, the British on a limited basis employed herbicides to destroy the crops of communist insurgents in Malaya.

In 1961, President Ngo Dinh Diem of South Vietnam asked the United states to conduct aerial herbicide spraying in his country. In August of that year, the South Vietnamese Air Force initiated herbicide operations with American help. But Diem's request launched a policy debate in the White House and the State and Defense Departments. On one side were those who viewed herbicides as an economical and efficient means of stripping the Viet Cong of their jungle cover and food. Others, however, doubted the effectiveness of such a tactic and worried that such operations would both alienate friendly Vietnamese and expose the United States to charges of barbarism for waging a form of chemical warfare. Both sides agreed upon the propaganda risks of the issue. At last, in November 1961, President Kennedy approved the use of herbicides, but only as a limited experiment requiring South Vietnamese participation and the mission-by-mission approval of the United States Embassy, the Military Assistance Command Vietnam, and South Vietnam's government.

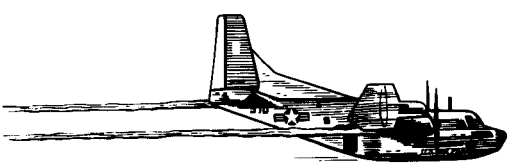
Operation Ranch Hand, the designation for the program, began in January 1962. Gradually limitations were relaxed and the spraying became more frequent, and covered larger areas. By the time it ended nine years later, some eighteen million gallons of chemicals had been sprayed on an estimated twenty percent of South Vietnam's jungles, including thirty-six percent of its mangrove forests. The Air Force also carried out herbicide

operations in Laos from December 1965 to September 1969 with the permission of the Laotian government.

One of a series of books detailing the Air Force's involvement in the war in Southeast Asia, this volume was written by Major William A. Buckingham, Jr., while assigned to the Office of Air Force History. The author rightly emphasizes that the Air Force served as an instrument of national policy in conducting the herbicide spraying. The book is a model study of the process by which military policy was made in the Southeast Asia War. Major Buckingham relates the intense controversy, both within the government and among the public, over the military, political, and ecological effects of the program. He connects policy to the operations, showing how pressure from scientists and disagreements among government policymakers and military leaders imposed limitations on the spraying program. He explores the technical difficulties in using herbicides: the right chemical agents had to be delivered in sufficient quantity at the optimal time of the growing season, only against certain crops and categories of vegetation, and only in areas where the destruction provided harm to the enemy and no danger to friendly or neutral populations. And Major Buckingham pays tribute to the bravery of the Ranch Hand airmen who flew their planes "low and slow" over territory often heavily defended by the enemy. Remarkably, Ranch Hand's UC-123 Providers took more than seven thousand hits from ground fire, but lost only a few crews and aircraft. Indeed, the most celebrated of the planes, "Patches," survived over six-hundred hits.

The Ranch Hand operation was unique in the history of American arms, and may remain so. In April 1975, President Ford formally renounced the first use of herbicides by the United States in future wars. "As long as this policy stands," Major Buckingham writes, "no operation like Ranch Hand could happen again."

RICHARD H. KOHN
Chief, Office of Air Force History



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I am indebted to each of these people, and many more, and I credit much of the improvement in the book to their help. Of course, I accept responsibility for all errors which remain.

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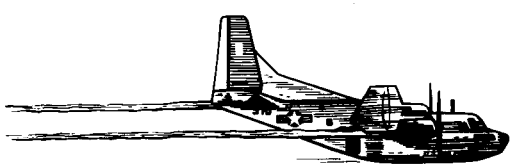

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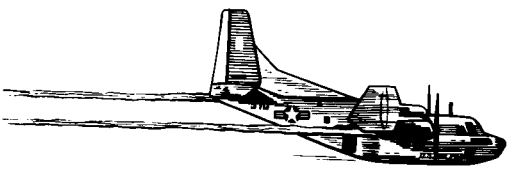


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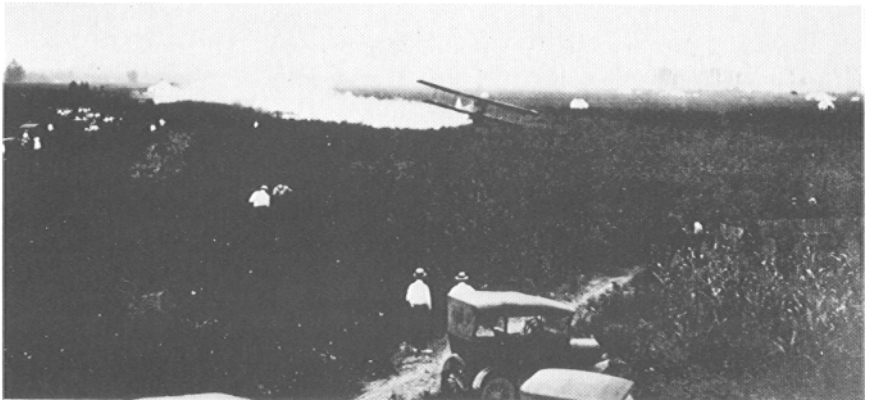
I. The Development of a Military Herbicide Capability

The problem of controlling insects in agriculture and forestry provided the initial spur for the development of the capability to deliver chemical sprays and powders from aircraft. Spraying poisonous liquids on leaf-eating insect pests using equipment located on the ground became accepted practice after World War I. Foresters used engine-driven pumps and, sometimes, thousands of feet of hose to control moth infestations in tall trees, but high labor costs and the inability of spraying rigs to reach the treetops made this method unsatisfactory. An entomologist from Cleveland, C. R. Neillie, believing that airplanes could be used to dust a stand of trees, worked with the Army Air Service at McCook Field in Dayton to test the idea.

The first experiments, on an infestation of sphinx caterpillars in a grove of catalpa trees near Troy, Ohio, were conducted on August 3, 1921. Lt. John A. Macready piloted a converted Curtiss JN-6 over the grove. J. S. Houser, an experienced forest entomologist, rode in the passenger's compartment. As Lieutenant Macready flew the plane about 25 feet above the treetops at a speed of 80 miles per hour, Houser turned a crank on a 32 gallon hopper attached to the right side of the fuselage and filled with poison dust. The wind blew the resulting dense cloud of lead arsenate over and into the trees. The two men flew across the grove six times, each pass taking about nine seconds. Within two days it was obvious that this experiment had been a resounding success. Thousands of dead caterpillars were hanging from the trees and lying on the ground. Observations six days after the dusting showed that 99 percent of the destructive caterpillars had been killed. Considering that the total time required to apply the dust from the air had been less than one minute, and comparing this with the time-consuming and laborious ground spraying method, the airplane had clearly proved its worth as a delivery vehicle for agricultural chemicals.

The success of this early aerial dusting experiment led to the use the following year of the airplane to control leaf worms on cotton plants in Louisiana. Air Service planes and pilots were also involved in these still experimental, but successful, spraying flights. The commercial potential of the new technology was obvious, and, by 1924, civilian aerial crop dusting concerns were in existence. In 1927, commercial dusters treated about 500,000 acres with insecticides. The early efforts using Air Service pilots and aircraft had proved the usefulness of the airplane for delivering chemicals, and exploitation of this new tool was soon underway.[1]

Meanwhile, military interest in the airplane for spraying and dusting purposes concentrated on chemical warfare applications. A study completed in 1933[2] provides a good view of the thinking in the Air Corps during



Top photo: a crop duster over a Mississippi cotton field; center: the air suction hopper on this spray plane of the early twenties includes an outlet for discharging dust and a lever arm for opening and closing the feeder valve (the hopper lid is open); left: Lt. John A. Macready.

this period. A primary assumption was that, in future wars, air forces would find chemicals to be attractive weapons, at least from a purely military standpoint. Compared with the other types of weapons carried by aircraft of the time, chemicals were highly destructive. Another forecast was that attack aviation, or what we today label tactical strike aircraft, would play the primary role in delivering chemicals by the spray method.

The report maintained that the chemicals used would be of three types: lethal and non-lethal agents, screening smoke, and incendiaries. One idea set forth, which was later revived and tested in Southeast Asia, was to use incendiaries to set fires in dry, wooded areas. The authors also proposed using chemicals to deny the opposition the use of rear areas and lines of communication. While planning in the 1930s involved the use of lethal agents, the Air Force used herbicides in Southeast Asia to remove jungle cover for these identical purposes.

By the 1930s the Air Corps had discovered the basic principles of aerial chemical delivery which would guide the use of herbicides in the 1960s. The techniques involved in carrying liquids in metal tanks aboard aircraft and discharging them through suitable nozzles were already well-established. Pilots had developed low-altitude delivery tactics, and they understood the effects of atmospheric convection, wind, and temperature on a spray mission. Drills, tests, and exercises continued through the remaining interwar years, and the Air Corps was well-prepared to conduct this type of operation when World War II began.

While military aerial spray activities in the United States went no further than drafting plans and conducting exercises during this period, in 1936 the Italian Air Force in Ethiopia used the airplane to deliver chemicals in combat. The use of gas during Italy's annexation of Abyssinia resulted in much political and moral condemnation of the Italians. However condemned, it was effective. One war correspondent maintained that S-81 bombers of the Italian Air Force dropping a type of mustard gas powder halted the only real Ethiopian threat of the war and saved the Italians from disaster.[3] Haile Selassie in his speech to the League of Nations maintained that:

> Special sprayers were installed on board aircraft so they could vaporize over vast areas of territory a fine, death-dealing rain. Groups of nine, 15 or 18 aircraft followed one another so that the fog issuing from them formed a continuous sheet. . . . These fearful tactics succeeded. . . .[4]

Disagreements arose over the extent of the Italian effort and the identity of the chemicals used, but this episode nevertheless was a telling demonstration of aerial delivery of chemicals in combat.

During World War II, international legal restrictions and mutual restraint on the part of participants in the conflict kept American aviators from employing their skills in the delivery of lethal chemical sprays. Ironically, the spray equipment and flying techniques developed in the 1930s as part of the Air Corps' most destructive weapons were used in the 1940s in

the Pacific to save lives. Allied forces in the tropics experienced high rates of infection from mosquito-spread diseases. In fact, the casualties attributed to malaria and other insect-borne diseases exceeded those caused by enemy bullets. When the insecticide DDT was coupled with the proven spray capabilities of the airplane, a potent weapon was made available to use in fighting this menace.[5]

World War II was also significant in providing background for the future events in Southeast Asia in that experiments were conducted in spraying defoliants from aircraft for military purposes. Such experiments in 1944 at Bayport and Marathon, Florida, at the direction of the Army Air Forces Board, tested the effectiveness of water solutions of zinc chloride and ammonium thiocyanate as defoliants of tropical vegetation. A-20 aircraft, carrying four standard 25-gallon M-10 tanks each, sprayed the test areas from altitudes of between 50 and 500 feet. Measurements were kept to determine the visibility of color changes produced in the vegetation by the spray, the increase in visibility within the forest as a result of defoliation, the change in the flammability of the foliage after treatment, and the amount of time needed for these effects to reach their maximum.

The conclusions drawn from these tests were generally unfavorable to the widespread use of defoliants. Chemically induced color changes proved impractical for marking bomb lines in fluid tactical situations, because the geographical distribution of forces could change significantly in the minimum period of 24 hours the tests showed were needed for visible color changes to develop. The use of chemicals in removing jungle cover to increase visibility was considered equally impractical because of the five to seven days needed for any appreciable defoliation to occur. The tests also showed that neither ammonium thiocyanate nor zinc chloride would increase the flammability of jungle vegetation. However, the researchers did conclude that aerial chemical spray could be used to mark rendezvous points or navigational aids on the crowns of dense jungle forests when appropriate advance notice was available. The most important tactical application discussed in the Board's report was the use of aerial spray to kill or damage food crops grown by isolated Japanese units on Pacific islands. Although these World War II tests did not lead to any large-scale operational program, it will be seen that the concerns expressed and the applications investigated in 1944 were closely paralleled in South Vietnam.[6]

Because the tactical situation and the vegetation in Korea were not conducive to the use of aerially sprayed herbicides (although mosquito spraying took place there), the next armed conflict in which herbicides found significant use was the British campaign against communist guerrillas in Malaya, formally known as the Malayan Emergency. The Emergency lasted from about 1948 to about 1960, but the role of herbicides was important only after 1952—primarily in 1953 and 1954. During this period, the British used helicopters and, occasionally, fixed-wing aircraft to spray food crops in isolated gardens tended by the insurgents. However, the aerial spray effort was

only one part of a much larger program designed to restrict supplies of food which could be used to support the communist insurgents. Because of the effectiveness of the British food control program, the insurgents, by late 1952, had been forced to withdraw from populated areas into deep jungle to cultivate their own food. Food production became the determining factor affecting their ability to survive.

In exploiting this situation, the British placed high priority on destroying the insurgents' cultivation plots hidden in the jungle. Ground troops sometimes destroyed the plots, but such use of troops proved to be uneconomic. As a result, S55, S51, and Whirlwind helicopters were used to spray the gardens with herbicides. The technique generally followed was to have Auster reconnaissance aircraft spot the plots and mark them, after which pairs of Hornets strafed the area to eliminate any ground resistance. The helicopters then descended over the plots and sprayed them with herbicides. At first, the British used sodium arsenite, but the danger it posed to the indigenous population was politically unacceptable. The most effective spray was a mixture of trioxene and diesolene which both killed the crops and rendered the soil sterile for a time.

As an indication of the level of intensity of these operations, in 1953, 88 cultivation plots were destroyed, the result of 63 hours of helicopter time devoted to spray missions. The crop destruction helped make the insurgents' jungle camps untenable, thereby forcing them to contact their supporters in the populated areas and increasing the chance that they would encounter British forces. However, the lack of sufficient helicopters and other aircraft to adequately pursue the crop destruction mission in addition to other tactical mission requirements, plus the difficulty in distinguishing insurgents' plots from those of the general population, resulted in crop spraying operations being held in abeyance after about 1954.[7]

In the United States, research and development in chemical herbicides was undertaken during the 1950s. A considerable amount of effort also went into improving the delivery equipment. In February, March, and April 1950, anticrop aerial spray trials were conducted at Avon Park Air Force Base, Florida, to determine whether C–47s could effectively spray undiluted chemicals from hollow cone nozzles. Later that same year, B–17 and B–26 aircraft conducted similar tests.[8]

There was also a need for a large capacity spray system that B–29, B–50, and C–119 aircraft could carry. An engineering study completed in 1952 laid the groundwork for the development of the MC–1 "Hourglass" system. The nickname referred to the speed with which the system was later developed and produced. By 1958, it had become a standardized item in the Air Force inventory.

Built by the Hayes Aircraft Corporation of Birmingham, Alabama, the MC–1 system included: a 1,000-gallon cylindrical aluminum tank insulated by a thick fiberglass blanket; a centrifugal pump; a control valve between the tank and the pump; a pipe assembly with fittings for six spray nozzles;

an opening for dumping the chemical contents in an emergency; an outlet for the connection of a recirculating and heating unit; and a dual set of controls and instruments.[9] The B-29 and B-50 could carry an MC-1 in each of their two bomb bays, and a C-119 could carry one MC-1. The Air Force eventually bought 100 units, placing them in storage, along with chemicals, at Spokane. They later became the basis for the spray equipment installed aboard the Ranch Hand C-123s.[10]

In June 1959 an experiment at Camp Drum, New York, proved the value of aerially dispensed herbicides in improving visibility for military operations. Sugar maple foliage there hampered observation of shell bursts on an artillery firing range and needed to be removed. As was often true later in Vietnam, ground access to the area was impossible, but in this case because of unexploded artillery rounds rather than enemy activity. The Army Biological Warfare Laboratories sent Dr. James W. Brown, later involved in the earliest stage of the herbicide program in South Vietnam, to Camp Drum to assist in solving the problem.

Surplus drums of butyl esters of 2,4-D and 2,4,5-T* were obtained from the Air Force's original (1952) stock. Camp Drum personnel then devised an experimental spray system for use in an H-21 helicopter. Their system consisted of two 55-gallon stainless steel tanks; a gasoline engine driven pump; and a 23-foot spray boom with 24 nozzles. The H-21 sprayed a 1 : 1 mixture of 2,4-D and 2,4,5-T on the offending vegetation from 25 to 75 feet above the treetops at an airspeed of about 30 miles per hour. The deposition rate achieved was slightly more than one half-gallon per acre. The spray caused the desired effects, but not immediately. The dried leaves began to fall one month later.[11]

While research went on elsewhere to develop anticrop chemicals and aerial delivery techniques, a unit at Langley Air Force Base, Virginia, was compiling an extensive record of operational spray missions—dispensing insecticides rather than herbicides. This unit, the Special Aerial Spray Flight (SASF) of the Tactical Air Command (TAC), later provided the aircraft and trained spray crews for the initial defoliation operations in South Vietnam.

The Special Aerial Spray Flight's origin can be traced to the successful antimosquito spray operations in the closing months of World War II. After the war ended, the IX Troop Carrier Command acquired the operational spray mission, and the Air Force became responsible for aerial spraying when it became a separate service in 1947. In January 1948, the Special DDT Flight, as it was then known, was transferred to Langley AFB. During the next twelve years, the Special Aerial Spray Flight, a name it acquired in 1951, experienced many changes in its organizational assignments, but Langley continued to be its home base. For much of this time, the Special

*See Appendix 1, p. 195, for a discussion of these and other herbicides.

Aerial Spray Flight was not a unit in the normal sense—there was no permanent organization, just a collection of personnel authorizations which different people filled each year to undertake the seasonal spray missions. Under these circumstances, retention of experienced pilots with the necessary, highly specialized skills was a continual problem.

Operationally, in the fifteen years following World War II, the Special Aerial Spray Flight and its predecessors sprayed 69 different government installations while flying approximately 1,200 insecticide missions, largely in the eastern United States. In addition to the normal insect control activity, the spray planes flew special missions in times of disaster and for the purpose of testing new insecticides and equipment. The flight was called into service to combat plagues of grasshoppers in Kearney, Nebraska, and infestations of black flies in Maine. It also sprayed flies breeding on thousands of acres of dead fish killed by red tides along the Florida coast. The flight also participated in chemical and biological warfare research and flew several missions in 1951 in cooperaton with the Biological Warfare Center at Camp Detrick, Maryland.

Three C-47 aircraft were assigned to the spray mission in 1946, and the Special Aerial Spray Flight used these same planes through 1960. The only additional aircraft assigned to the unit in fourteen years were three single-engine L-20 Beavers. The equipment allocated to the Special Aerial Spray Flight gives some indication of the relatively low priority the Air Force assigned to the spray mission during most of the pre-Vietnam period.[12]

Despite the low priority, by 1959 efforts were underway to acquire spray-equipped C-123s. The need for that aircraft became even more urgent in 1960 when the possibility arose that the Special Aerial Spray Flight might go out of business with the proposed elimination of C-47s and L-20s from the Air Force inventory. A severe shortage of spare parts for these aircraft already existed. In light of the situation, a preliminary planning conference was convened at Langley on August 16, 1960 to discuss acquiring and equipping of C-123s. Representatives from TAC, the Army, Navy, and U.S. Department of Agriculture attended. Capt. Carl W. Marshall, the Officer in Charge of the Special Aerial Spray Flight, who was later to command the first Ranch Hand detachment, chaired the conference. He proposed that the C-123 be modified to dispense both liquid and granular insecticides. The MC-1 spray system, teamed with the Navy's HIDAL (Helicopter Insecticide Dispersal Apparatus, Liquid) booms, could dispense liquid insecticides. A 10,000-pound-capacity hopper with a gravity feeding system and commercial spreaders could handle granular insecticides. However, with the knowledge that C-123s were in short supply, and that very complete justification would be required to reassign any to the aerial spray mission, the conferees concluded that only one C-123 should be obtained on a temporary basis to test both the liquid and the granular systems. If these tests proved successful, the group supported modification of three aircraft.

This planning conference had concerned itself almost entirely with the C-123 as a dispenser of insecticides. Only one brief mention was made of another possible requirement which was later to be far more important. Captain Marshall at one point said that the aerial spray system installed on the C-123 should also be able to deliver biological and chemical warfare decontaminants and neutralizers, and vegetation control chemicals. These additional capabilities, however, should not reduce the system's capability to spray insecticides. Almost a year after the conference, the deteriorating situation in South Vietnam caused the modified C-123's secondary capability to deliver herbicides to become very important to officials at the highest levels of the American government.[13]

II. The Decision to Send Spray-Equipped C-123s to South Vietnam

The question of what to do about Vietnam was waiting for President Kennedy's attention when he took office on January 20, 1961.[1] Worried cables had been flowing between Saigon and Washington for a year or so, but no sense of urgency had yet developed. For the previous eight months, a Counterinsurgency Plan for South Vietnam had been percolating through the Washington bureaucracy, and, after just one week in office, President Kennedy approved it. The plan offered to add some $42 million to the current $220 million U.S. aid program for Vietnam to enable enlargement of the South Vietnamese military forces. In return, South Vietnamese President Ngo Dinh Diem was asked to consolidate his military chain of command and to institute certain civic reforms. An underlying assumption of the plan was that if Diem would take the needed corrective civic measures and build adequate military forces, then the South Vietnamese government would have the potential to handle the threat posed by the Viet Cong.

The Counterinsurgency Plan soon ran into trouble as President Diem delayed the implementation of his side of the bargain in a pattern of inaction he was to repeat often during the remaining 33 months of his rule. The Joint Chiefs of Staff and the American military mission in Saigon were anxious to see the war against the Viet Cong accelerated, but Washington withheld its approval of increased American aid as long as Diem stalled. Despite these troubles with Diem, some elements of the American government and military leadership felt that the time to act against the Viet Cong in South Vietnam had come, that any further delay might threaten the eventual survival of a non-communist South Vietnam. Consequently, the Kennedy Administration developed plans and made many important decisions concerning Vietnam during its first year.

The series of events which led to the decision to send C-123s to South Vietnam to spray herbicides seems to have begun on April 12, 1961. On that date, Walt W. Rostow, a foreign affairs advisor to President Kennedy, forwarded a memo on Vietnam to the President.[2] He proposed a high-level meeting in the near future to consider "gearing up" the whole Vietnam operation as elections there had recently been held, and President Diem should therefore be free to undertake the reforms proposed earlier. Nine

specific courses of action were mentioned in his memo. The fifth one recommended that a military hardware research and development team go to Vietnam to work with the chief of the U.S. Military Assistance Advisory Group (MAAG), Army Lt. Gen. Lionel C. McGarr, in exploring the usefulness there of various "techniques and gadgets" then available or under development. Aerial defoliation later became one of these unspecified "techniques and gadgets."

Later that same month, Roswell L. Gilpatric, Deputy Secretary of Defense, submitted a memorandum to President Kennedy which contained the proposals of an interdepartmental task force.[3] These proposals comprised a multifaceted program designed to prevent a Viet Cong victory in South Vietnam. Among the military actions recommended was one to " . . . assist the G.V.N. [Government of (South) Vietnam] to establish a Combat Development and Test Center in South Vietnam to develop, with the help of modern technology, new techniques for use against Viet Cong forces." President Kennedy approved this recommendation and several other quite limited military proposals contained in the task force report at a National Security Council (NSC) meeting on April 29.

Shortly thereafter, the President decided to send Vice President Lyndon B. Johnson to reassure U.S. allies in Southeast Asia. The Vice President was also to personally deliver a letter to President Diem.[4] The letter, signed by the President on May 8, discussed Administration concern about events in Vietnam and the possibilities of an expanded joint U.S.-South Vietnamese program of action built on the existing Counterinsurgency Plan. Specific military measures listed in the letter as being in addition to actions in the Counterinsurgency Plan included augmenting the American personnel assigned to the MAAG; providing material support to the Vietnamese Navy's Junk Force assigned to suppress clandestine supply and infiltration by sea; jointly developing methods to control infiltration across South Vietnam's land borders; and establishing a facility to develop and test new, modern, techniques to assist in the anti-communist campaign. The letter also dealt with joint political and economic efforts, and closed with an expression of confidence in the ability of the South Vietnamese to handle the situation.

Three days later, at the May 11 meeting of the National Security Council, President Kennedy made and reaffirmed several decisions of long range impact. The U.S. objective in South Vietnam was to:

> . . . prevent Communist domination of South Vietnam; to create in that country a viable and increasingly democratic society, and to initiate, on an accelerated basis, a series of mutually supporting actions of a military, political, economic, psychological and covert character designed to achieve this objective.[5]

The President confirmed the specific military actions previously approved at the NSC meeting on April 29 and approved five additional actions he deemed necessary because of the increased security threat resulting from

events in Laos which made that country's border with South Vietnam less secure. Defoliation eventually came to be associated with the first two of these actions:

> (1) Assist the G.V.N. armed forces to increase their border patrol and insurgency suppression capabilities by establishing an effective border intelligence and patrol system, by instituting regular aerial surveillance over the entire frontier area, and by applying modern technological area-denial techniques to control the roads and trails along Vietnam's borders. . . .
>
> (2) Assist the G.V.N. to establish a Combat Development and Test Center in South Vietnam to develop, with the help of modern technology, new techniques for use against the Viet Cong forces.[6]

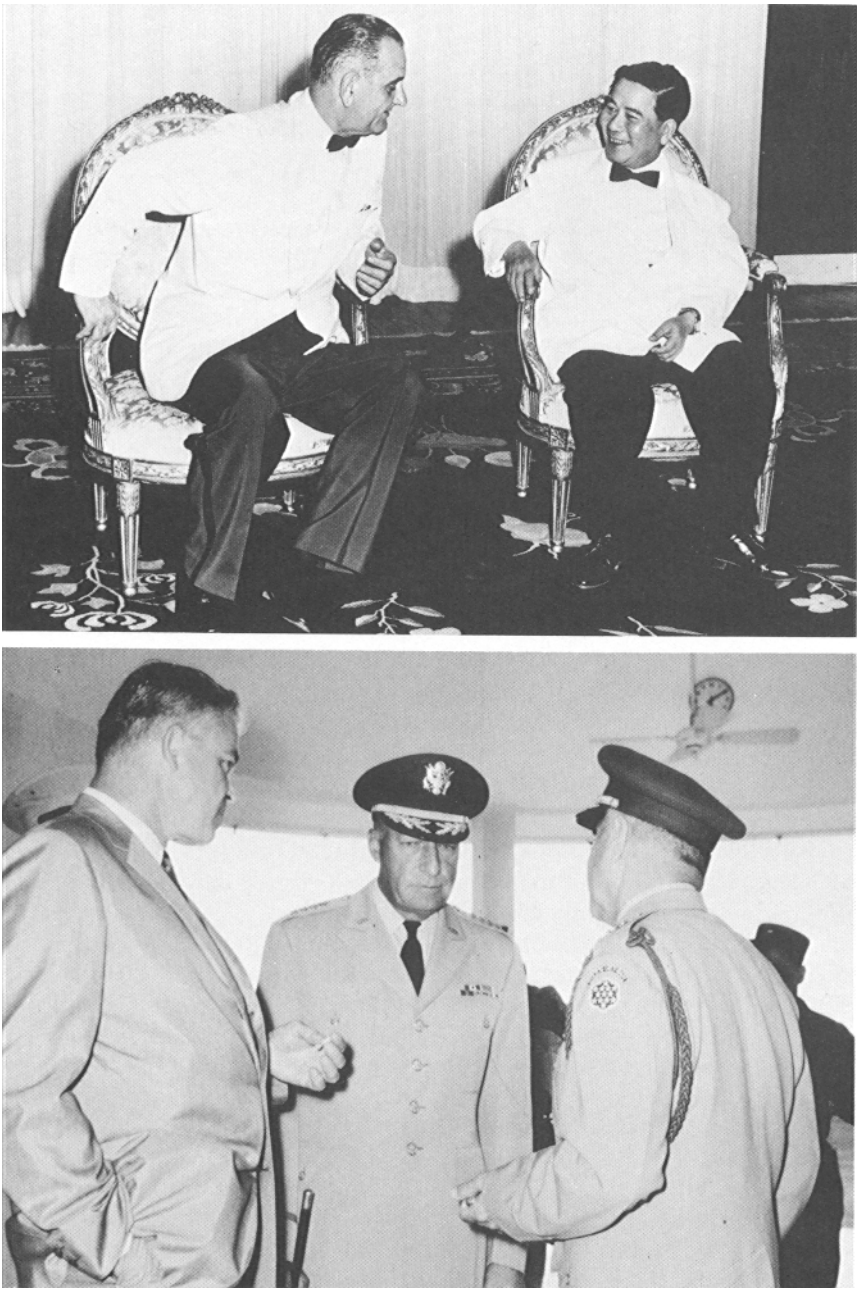
These two proposals, included in President Kennedy's May 8 letter, were accepted by President Diem—publicly in a joint communique with Vice President Johnson on May 13 and privately in a letter to Kennedy dated May 15.[7]

After the NSC meeting of May 11, the focus of action on border control and the exploitation of technology in counterinsurgency shifted from the White House to subordinate levels of the bureaucracy. On May 16, the Director of Defense Research and Engineering (DDR&E) was requested to initiate planning to send a team, at the earliest possible time, to assist the Vietnamese Armed Forces in employing new techniques and devices applicable to the guerrilla struggle in which they were engaged. The team was to be assigned to the Chief, MAAG Vietnam, on temporary duty and was to assist the Vietnamese in establishing a Combat Development and Test Center (CDTC). The mission of this group of experts was:

> . . . to acquire directly, develop and/or test novel and improved weapons and military hardware for employment in the Indo-Chinese environment, subject to political-psychological restrictions (such as those imposed by Communist claims of U.S. biological warfare in Korea).[8]

By July, thinking had progressed from general concepts of "techniques and gadgets" to specific proposals, including the use of defoliants. A report on developments as of July 10, 1961 stated that one research and development team had given attention to the problem of more effectively controlling South Vietnam's borders against unfriendly elements. This team considered using chemical plant killers for clearing "fire breaks" along the borders.[9] Also during the week ending July 10, defoliation chemicals had been shipped to Saigon for tests by the newly established Combat Development and Test Center. A few days later, another report stated that " . . . all components needed for an extensive defoliation test are now enroute to Saigon."[10]

A South Vietnamese Air Force (VNAF) H-34 helicopter equipped with a HIDAL spray system flew the first defoliation test mission in South Vietnam along a road north of Kontum on August 10, 1961. Exactly two weeks later, a VNAF C-47 flew the first fixed-wing spray mission. Both missions dispersed the herbicide Dinoxol. President Diem personally selected the target for the C-47 mission on August 24. It consisted of a four-kilometer stretch of Route 13 about 80 km north of Saigon near the village of Chon Thanh. The Special Aerial Spray Flight provided the spray equipment used



Top: Vice President Lyndon B. Johnson with President Ngo Dinh Diem; bottom, l. to r: Ambassador Frederick Nolting, Jr., Gen. Paul D. Harkins, COMUSMACV, and Lt. Gen. Lionel C. McGarr, CHMAAGV, in Saigon.

in the VNAF C–47 and also sent TSgt Leon O. Roe to South Vietnam to assemble and install it. Capt. Mario D. Cadori, an experienced spray pilot formerly assigned to the SASF but at that time serving in the Pacific Air Forces (PACAF) area, was sent to train the South Vietnamese pilots who flew this and other C–47 test missions in low-altitude spray techniques. Although American evaluations of the results of this particular test were disappointing, President Diem was reportedly impressed by the overall results of the tests. He remained thereafter a staunch supporter of the defoliation program.[11]

Within a few weeks of the first test, President Diem discussed the use of herbicides with a different type of target in mind. On September 29, 1961, at Independence Palace in Saigon, Diem and his advisors met with an American delegation which included Ambassador Frederick E. Nolting; General McGarr, chief of MAAG, Vietnam (CHMAAGV); and Adm. Harry D. Felt, Commander in Chief, Pacific (CINCPAC). Their discussion covered a wide range of issues, and towards the end it turned to the question of Viet Cong crops. President Diem expressed concern about there being large areas in the remote regions of his country where the Viet Cong had forced Montagnards to clear land and plant rice. Within about a month, he said, there would be a considerable amount of food for the enemy to harvest. He therefore proposed that immediate efforts should be made to destroy these crops before they could be harvested. Diem stated that he had heard of a "powder" which could be used to destroy the rice, but that President Kennedy would first have to authorize its use. After some discussion it was concluded that Diem's advisors had confused an available defoliant with other, more powerful, substances which probably fell into the closely-controlled area of chemical, biological, and radiological (CBR) weapons. Nevertheless, Diem stated that he did not care what was used as long as the Viet Cong could be denied access to the crops in these remote areas.[12] The meeting ended without any commitment from the American representatives about this matter.[13]

The situation in South Vietnam again came to the forefront in Washington in the fall of 1961. Although the official reports of "progress" in Vietnam at the beginning of this period were not pessimistic, there was an air of bleakness in the unofficial communications channels. Theodore H. White wrote the White House in August that the situation was getting worse week by week and that Diem's government suffered from a formidable political breakdown. He also reported that the Viet Cong controlled almost all of the southern Mekong Delta region and that he could find no American who would drive him outside Saigon, even by day, without a military escort. White's bleak assessment was confirmed when the number of guerrilla attacks tripled in September. That month also saw morale in Saigon shattered by the seizure of Phuoc Thanh, a provincial capital only 55 miles away. The Viet Cong controlled the town for several hours, publicly beheaded the province chief, and left before Diem's troops could arrive. This deteriorating, or, at best, stagnating situation led to another round of high-level decision-making on Vietnam.

On October 10, a paper entitled "Concept of Intervention in Vietnam" was discussed at a meeting attended by both the Secretaries of State and Defense.[14] The main thrust of the paper, drafted mainly by Deputy Under-Secretary of State Alexis Johnson, presented a concept for introducing United States forces into South Vietnam, preferably under a Southeast Asia Treaty Organization or United Nations umbrella, possibly in conjunction with a similar military intervention in Laos. The military objective of such a move would be to secure South Vietnam's borders against the infiltration of men and supplies from North Vietnam, a mission a force of 22,800 men could handle. However, a supplemental note to the paper issued the next day postulated that "cleaning up" the Viet Cong threat would require about 40,000 U.S. troops, and as many as 128,000 might be needed if North Vietnam and China overtly intervened. Defoliation operations were one of several proposed supplemental actions which could be carried out right away while a decision was pending on the major issue of committing large numbers of combat troops. The original Johnson paper proposed that U.S. aircraft be used to conduct a "major defoliant spray program in South Vietnam," although the aircraft would carry South Vietnamese markings and the pilots would wear civilian clothes. A supplemental note, dated October 11, phrased the defoliation proposal somewhat differently:

> Carry out defoliant spray operations, using hired commercial planes and pilots (CIA). These operations would initially be experimental, designed to prove out and further develop the capability to use defoliant sprays to clear off jungle access routes.[15]

An October 11 National Security Council meeting with President Kennedy also dealt with the Johnson paper. According to the recollection of one of those in attendance, the only immediate action approved by President Kennedy was the sending of the Air Force's "Jungle Jim" counterinsurgency squadron to South Vietnam to carry out a training mission under the MAAG. The President deferred a decision on the major question of sending large numbers of American troops to South Vietnam as well as on the other alternatives, including defoliation. Instead, President Kennedy decided to send a delegation headed by Gen. Maxwell Taylor to Saigon to investigate the political and military alternative actions. He also directed the State Department to undertake related diplomatic efforts.[16]

Meanwhile, the proposal to conduct a major defoliation operation was being more fully developed. As early as September 23, a joint State–Defense message had stated that emergency actions were needed to support the Diem government and suggested that defoliants for an operational program be included in a list of items to be delivered without delay.[17] The Combat Development and Test Center developed a massive operational program at about the same time on the basis of favorable results from tests on manioc and on jungle foliage. The plan had four goals:

> a. Stripping the Cambodian-Laotian-North Vietnam border of foliage to remove protective cover from Viet Cong reinforcements;

b. Defoliating a portion of the Mekong Delta area known as "Zone D" in which the Viet Cong have numerous bases;

c. Destroying numerous abandoned manioc groves which the Viet Cong use as food sources;

d. Destroying mangrove swamps within which the Viet Cong take refuge.

And it was to be conducted in two phases:

PHASE I: Defoliate within 30 days twenty percent of Zone D and adjacent Cambodian border, manioc groves and mangrove swamps.

PHASE II: In ninety days after completion of Phase I, defoliate remaining eighty percent of area D, the entire border, remaining manioc groves and mangrove swamps in Viet Cong dominated areas.

Counting both phases, this proposal envisioned the defoliation of 31,250 square miles of jungle, an area equivalent to about half of South Vietnam! In addition, the proposal called for spraying 1,125 square miles of mangrove swamps and 312.5 square miles of manioc.

The projected cost of the CDTC proposal—$75 to $80 million—and the fact that it would have consumed chemicals at a rate which would have exceeded the existing manufacturing capacity in the U.S. pointed up its excessive scope.* The proposal suggested that the spraying could be done by six C–47 aircraft with crews, maintenance personnel, and spray rigs provided by the U.S. Air Force, plus four Army helicopters and a number of ground-based spray units. The plan also called for the defoliated areas to be burned where they were sufficiently dry, an action which would facilitate their later use as farmland. The proposal cautioned, however, that the defoliation program would only be of value in helping to defeat the Viet Cong if it were accompanied by a vastly increased Army of the Republic of Vietnam (ARVN) offensive effort to exploit the results. The planners also recognized that such a program could expose the United States to charges of conducting chemical or biological warfare.[18]

Another suggested defoliation program of lesser scope devised by American officials in Saigon replaced the massive CDTC program a few days later.[19] This more limited plan consisted of three sequential programs. Phase I, to begin within twenty days, would spray 334.5 square miles of manioc and rice crops with 2,4,5-T and cacodylic acid. The second phase would begin within 65 days, last about thirty days and defoliate 200 square miles of jungle in Zone D with 2,4-D and 2,4,5-T. This second phase would be coordinated with military actions. During Phase III, certain unspecified border areas would be selectively defoliated. The overall cost of the revised program was estimated at $4 million to $6.5 million, less than a tenth of the

*Brown maintains that the excessive size and cost of this proposal may have been due to an error in arithmetic or in message transmission. See Rprt, Dr. J.W. Brown, U.S. Army Chemical Corps Biological Laboratories, subj: "Vegetational Spray Tests in South Vietnam, Supplement," April 1962, p 68.

cost of the original proposal. The proposal for the reduced program also indicated shortcomings in the use of C–47 aircraft for disseminating defoliants, and stated that aircraft in the United States (presumably, C–123s) could be equipped with the MC–1 spray system within a few weeks if sufficient priority were assigned to the task.[20]

In a memorandum dated November 3, 1961, the Joint Chiefs of Staff recommended to the Secretary of Defense, Robert S. McNamara, that Admiral Felt be authorized to implement the limited, three-phased defoliation plan. The JCS memorandum also stated that these operations should be carried out " . . . in conjunction with fully coordinated attacks on Viet Cong forces." The Chiefs advised caution, however, on crop destruction:

> 3. The Joint Chiefs of Staff are of the opinion that in conducting aerial defoliant operations against abandoned manioc (tapioca) groves or other food growing areas, care must be taken to assure that the United States does not become the target for charges of employing chemical or biological warfare. International repercussions against the United States could be most serious. In this connection, it is recommended that the operations be covered concurrently with a publicity campaign as outlined by Task Force Vietnam in Saigon.[21]

This last recommendation may have reflected doubt on the part of Gen. Lyman L. Lemnitzer, the Chairman of the Joint Chiefs of Staff, over the value of a crop destruction operation in Vietnam. The previous month, he had written Gen. Maxwell Taylor, military advisor to President Kennedy, and cautioned him against drawing too many parallels between the British experience in Malaya and the situation facing the Diem government in South Vietnam. He pointed out that food had been scarce in Malaya, and this had made the British food denial program an important and readily usable weapon. General Lemnitzer contrasted this with the relative plenty in South Vietnam, thereby questioning the wisdom of conducting a food denial campaign there.[22]

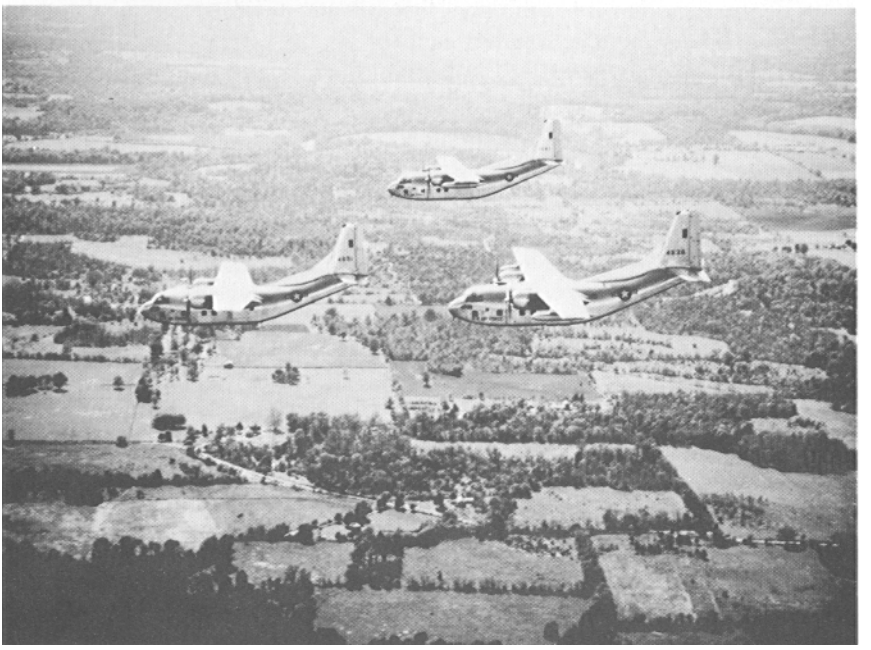
Secretary McNamara responded to the recommendations of the Joint Chiefs on November 7. He, too, was concerned about the possibility of an adverse propaganda impact, but he did not limit his concern to the food denial phase. He stated that the American Embassy in Saigon had been asked to comment on the possibility of persuading President Diem to assume responsibility for the proposed program and to issue an explicit public statement which would include the assertion, believed at that time, that the spray would not be harmful to livestock or humans. Pending the solution to this problem of defending the defoliation program against adverse propaganda, Secretary McNamara said that he could not decide whether or not to carry it out. He did, however, recognize the restraints imposed by time on any attempt to attack the fast-maturing Viet Cong crops. Accordingly, to preserve his options, Secretary McNamara directed the Air Force " . . . to provide, on a priority basis, the required aircraft, personnel, and chemicals." He assigned operational control of the project to CINCPAC.[23]

One week later, William P. Bundy, Acting Assistant Secretary of Defense for International Security Affairs, forwarded a memorandum to Secretary McNamara on the defoliation question which summarized recent developments and further examined the rationale for the program. In describing the food denial aspect of the proposal, Bundy stated that the actual spraying for this phase would be carried out by Vietnamese helicopters and personnel, although the use of U.S. Marine helicopters from Okinawa or Japan was still under consideration. Air Force C-123s would undertake the other two phases involving the removal of jungle cover. The Tactical Air Command had been notified on November 9 to modify six C-123s for spraying purposes and had been directed to send the planes to Southeast Asia to join the Jungle Jim unit already in South Vietnam. Bundy also reported that the Air Force had procured, from the Army, the chemicals required for the first phase of the operation and that they were being flown to Vietnam. Ships would transport the chemicals for subsequent phases. In addition, spray rigs for use on VNAF H-34 helicopters had been requested from CINCPAC resources; they would be available within one week. Bundy confirmed that Admiral Felt had assumed operational control of defoliant operations in accordance with McNamara's directive and had, in turn, delegated planning and coordinating responsibility to the Chief, MAAG Vietnam.

Bundy also outlined the various favorable and unfavorable aspects of the proposed defoliation program in more detail. On the plus side, he noted that U.S. diplomatic and military representatives in South Vietnam had recommended approval without reservation. In addition, preliminary tests were favorable, and approval would comply with President Diem's wishes. The negative aspects included the distinct probability that the North Vietnamese would exploit propaganda aspects of a defoliation program by making charges of chemical or biological warfare. Bundy also pointed out that for the plan to produce any military benefits, the South Vietnamese would have to provide ground troops and a coordinated plan to use them. In conclusion, Bundy stated that from the military standpoint, the program should be approved. However, in light of the political and psychological warfare risks involved, he recommended that President Kennedy be asked to give the final clearance.[24]

As William Bundy had suggested, the defoliation proposal was sent to President Kennedy for a final determination. In making his decision, the President had before him the written recommendations of both the Departments of State and Defense. The Deputy Secretary of Defense, Roswell L. Gilpatric, presented the Defense Department's position. He repeated most of the arguments which Bundy set forth but developed them more fully. He emphasized to the President that the proposed defoliation program would incorporate discriminative target selection and mission execution. He was, however, more concerned than Bundy with the political warfare aspects of the problem. He reported to the President that Radio Hanoi had announced

Top: C-123s at Hickam AFB, await deployment to Vietnam for defoliation activities; bottom: crewmembers board a C-123 Ranch Hand aircraft.



Top: Sec. Robert S. McNamara, Gen. Lyman L. Lemnitzer (3d from right), Gen. Paul D. Harkins, visit Americans in Vietnam, May 9, 1962; bottom: Fairchild C–123s.

on November 6 that the South Vietnamese had used "poison gas" on the rice crop near Tay Ninh, making people ill. Gilpatric conceded that killing crops in the remote areas of South Vietnam inhabited by Montagnards made sense militarily, but he was concerned about the possible effects on Montagnard attitudes and worried that " . . . the use of chemicals to destroy food supplies is perhaps the worst application in the eyes of the world." Another shortcoming was that Diem had no known plans to resettle the Montagnards. However, Gilpatric calculated that a crop destruction program could have a net favorable effect and the public relations difficulties could be mitigated if the problem of resettling and feeding the Montagnards could be solved.

Gilpatric likewise had substantial reservations about using defoliants in a major effort to clear Zone D near Saigon and to control South Vietnam's borders. His concern in both cases stemmed from a lack of confidence in the ARVN's capability to exploit the defoliation missions with ground action, without which defoliation alone would be of little or no value. In regard to the mounting of an organized ground attack in Zone D, he said ". . . it seems clear that it would be a stern test of Vietnamese capabilities and probably beyond what they could attempt in the present state of morale and organization." Similarly, concerning border control he stated, "Mere clearing will not accomplish a great deal, unless we are ready with helicopters and/or border patrol forces to patrol the areas and do a job." Both of these proposals for the use of defoliants, in Gilpatric's view, should be delayed pending the development of realistic plans along with the demonstration of a willingness and ability on the part of the South Vietnamese to properly exploit these aspects of the defoliation program.

The one proposed use of defoliants about which Gilpatric expressed an unreservedly positive view to the President was the clearing of key routes. He noted that such clearing would forestall ambushes and allow freer movement on transportation arteries and that this use of defoliants would not be substantially different from what was already being done in clearing rights of way in the United States. Gilpatric's view was that using defoliants on a modest basis to clear vegetation away from roads, railroads, and canals would be a desirable first use and a low-risk method for testing world reaction.

A significant and unresolved issue which Secretary Gilpatric described for the President concerned the markings to be carried on the defoliation aircraft and the nationality of the crews which would fly them. He noted again that the food denial operations could be carried out by South Vietnamese aircraft and crews but that the other missions would have to be flown by someone else. A possibility he mentioned was placing South Vietnamese markings on the aircraft (presumably Air Force C-123s) and having them flown by "covert" aircrews. Because of the nature of the aircraft, however, he did not feel that such measures would effectively disguise the U.S. role in the operation. He therefore recommended against the covert approach.

In his summary, Secretary Gilpatric presented to President Kennedy the Department of Defense view that there were two possible alternative decisions:

> a. To avoid the use of this material wholly on grounds of net adverse local reaction, and particularly of worldwide disapproval. On this, we have no clear judgment, since it depends on factors that can best be assessed by the Department of State.
>
> b. To go ahead with a selective and carefully controlled program starting with the clearance of key routes, proceeding thereafter to food denial only if the most careful basis of resettlement and alternative food supply has been created, and holding Zone D and the border areas until we have realistic possibilities of immediate military exploitation.

The Department of Defense preferred the second option. Gilpatric also emphasized his department's view that the use of defoliants should be closely controlled by Washington with "careful prior consideration and authorization" of the operational plans developed by CINCPAC and U.S. representatives in Saigon.[25]

Secretary of State Dean Rusk expressed the State Department's views on defoliation, and they were generally in agreement with Gilpatric's memorandum. Secretary Rusk told the President, "The use of defoliant does not violate any rule of international law concerning the conduct of chemical warfare and is an accepted tactic of war." He cited the British crop-spraying operations in Malaya as a precedent. However, he warned that the United States would probably become the target of an intense "germ warfare" campaign initiated by communist nations, and, perhaps, echoed by some neutral countries. Nevertheless, Rusk expressed the view that:

> . . . successful plant-killing operations in Viet-Nam, carefully coordinated with and incidental to larger operations, can be of substantial assistance in the control and defeat of the Viet Cong.

Accordingly, Secretary Rusk seconded Gilpatric's recommendation for a limited initial defoliation program restricted to transportation routes, with close control and supervision retained in Washington.[26]

President Kennedy accepted the joint recommendation of the Departments of State and Defense on November 30, 1961. His decision was straightforward and followed very closely the views of Gilpatric and Rusk:

> The President has approved the recommendation of the Secretary of State and the Deputy Secretary of Defense to participate in a selective and carefully controlled joint program of defoliant operations in Viet Nam starting with the clearance of key routes and proceeding thereafter to food denial only if the most careful basis of resettlement and alternative food supply has been created. Operations in Zone D and the border areas shall not be undertaken until there are realistic possibilities of immediate military exploitation.
>
> The President further agreed that there should be careful prior consideration and authorization by Washington of any plans developed by CINCPAC and the country team under this authority before such plans are executed.[27]

President Kennedy had committed the United States to a course of action which led to the extensive Ranch Hand defoliation and crop destruction operation in Southeast Asia.

At the time of his decision, Vietnam was by no means the most critical foreign and military policy problem facing President Kennedy's still-new administration. During the summer of 1961 the Soviet Union had precipitated a serious confrontation over continued Western presence in Berlin and affirmed an intention to unilaterally abrogate all Western rights there. The United States' response to this challenge included increasing draft calls, extending the tours of duty of servicemen, and calling up reserves. As a result, U.S. conventional forces were stretched thin. The Soviets had also unilaterally resumed atmospheric nuclear tests at the same time negotiations were underway to reach an agreement banning such tests. And, during April, when many important decisions involving Vietnam were being made, the Bay of Pigs invasion of Cuba was failing.

The situation in Laos was equally troubling. The pro-Western faction there, supported by the United States, suffered serious setbacks at the hands of Laotian forces supported by the Soviet Union. The United States almost sent troops into Laos in 1961, and many of the important decisions of that year regarding South Vietnam were made in light of, and, to some extent, in response to the more serious situation in Laos.

Even limiting the focus to South Vietnam, defoliation was a relatively minor issue in 1961. Much weightier options were under consideration. Just a few days before President Kennedy decided to use herbicides, he had faced a crucial decision on the issue of sending American troops to South Vietnam.[28] By contrast, defoliation was a lower priority issue.

III. The Deployment of Spray Aircraft to South Vietnam and Initial Defoliation Operations

As mentioned earlier, with Secretary McNamara's decision to send herbicides and spray planes to South Vietnam, the Tactical Air Command had been given the mission of providing six C-123s and support sufficient for four months of field operations.[1] Inquiries relative to the spray capabilities of the C-123 had begun in July, and it was no surprise to the Special Aerial Spray Flight when the formal tasking came. The SASF at Langley already had two C-123s at Middletown, Pennsylvania, undergoing modifications to equip them for future insecticide operations in the United States. These two aircraft, however, were old and six of TAC's better C-123s were selected from those on hand at Pope AFB, North Carolina. The six planes were sent to Olmsted AFB, Pennsylvania, for the installation of MC-1 "Hourglass" spray tanks. Mechanics there also removed all unnecessary equipment; installed aluminum alloy armor plating under and alongside the cockpit; placed in the cargo compartment an engine oil supply replenishment system consisting of a 55-gallon drum, a hand pump, and plumbing to each engine; and added the necessary lines and interconnections to allow the 1,000-gallon spray tank to be used for additional fuel. The SASF placed its other airplanes, with the exception of the two C-123s at Middletown, in flyable storage.[2]

SASF's six pilots and twelve enlisted men provided the nucleus of the original spray detachment deployed to South Vietnam. Volunteers from Pope AFB supplemented them. Maj. Charles F. Hagerty, then a captain at Pope, recalled that Capt. Carl W. Marshall, the SASF commander, had interviewed people at Pope who had earlier volunteered for Jungle Jim, the Air Force's counterinsurgency force, but who had not been selected to join that organization. Major Hagerty remembered that the Jungle Jim interview, conducted several months earlier, had consisted of ten questions and a "no" answer to any one was disqualifying. The first question was, "Would you go on a mission with extensive TDY?" Their difficulty increased, with the last two questions being something like "Would you wear civilian clothes?" and "Would you go knowing that if you were captured your government would disclaim any knowledge of you?" According to Major Hagerty's recollection, only bachelors were selected for Jungle Jim. (He was married.) However, the names of those who had volunteered were

retained, forming the pool from which Captain Marshall made his selections for the defoliation mission.[3]

Captain Marshall experienced no difficulty in obtaining volunteers, in spite of the fact that the men were initially told that they would wear civilian clothes, fly aircraft without USAF markings, and would not be acknowledged as members of the U.S. military if they were captured. The pilots obtained from Pope were experienced in the C-123, but of the fourteen pilots on the first deployment, only eight had experience in aerial spraying. And, with only about two weeks from the time they were selected until they left, there was no time for training until they reached the Philippines.[4]

The personnel selected for the deployment were told they were going TDY to Southeast Asia for some 120 days, but only those with a "need-to-know" found out that their destination was South Vietnam. The men received instructions to tell their families even less—that they would be going on extended temporary duty, but could not reveal their destination. They were also told not to write letters home until they received the "next briefing," which, in the recollection of Major Hagerty, they never received. There was, therefore, no officially sanctioned way for the defoliation personnel to communicate with their families until they returned from Vietnam. As a practical matter, their families learned where the men were and how they were getting along from other Air Force personnel, such as those assigned to the Mule Train C-123 transport unit, who knew the defoliation crews and came into contact with them in South Vietnam.[5]

Including aircrew members and support and maintenance personnel, 19 officers and 50 enlisted men went to Southeast Asia on the original defoliation deployment. Several C-124 transports carried some of the men along with spare parts for the C-123. On November 28, 1961, the six spray-equipped C-123s with 36 persons on board departed Pope AFB for Travis AFB, California. For the purposes of the deployment, they were included under the existing Farm Gate operations plan. On this long overland leg the crews kept careful records of fuel and oil consumption so as to enable them to plan for the extended overwater flights in their route across the Pacific. One hitch in the planning developed because filling the 1,000-gallon internal spray tank with fuel placed the C-123 at about 2,000 pounds over its design gross weight. They were not allowed to exceed this gross weight limit on the first overland leg, but the limit had to be exceeded for the trans-Pacific flight to provide adequate reserve fuel. Therefore, the C-123's pattern of fuel consumption at the higher weight could only be estimated prior to actually flying the leg from Travis to Hickam AFB, Hawaii.[6]

In spite of the earlier talk about "sanitizing" the crews and aircraft, little had been done as they began their deployment flight. The crewmembers

wore uniforms and were readily identifiable by their names and ranks. The aircraft still carried large "U.S. Air Force" markings and identification numbers. The flight did provide itself with a limited amount of cover by listing fictitious numbers and types of aircraft on flight plans and filing encoded position reports.[7]

In addition, aircraft parking areas at each enroute stop were to have special security arrangements. Obtaining the needed security caused Captain Marshall some degree of difficulty. An earlier message alerting the enroute bases about the special needs of the spray aircraft was evidently either not received or misrouted at some of the bases. This placed Captain Marshall in the difficult position of having to request unusual arrangements upon arrival at each base, while, at the same time, being unable to reveal details of the classified mission which made them necessary.[8]

At 0400, Pacific Standard Time, on November 30, 1961, the six spray aircraft departed Travis AFB for the flight to Hickam. About thirty minutes after takeoff, the number two aircraft experienced icing problems, declared an emergency, and returned immediately to Travis accompanied by the number three aircraft. The remaining four planes proceeded to Hickam along the planned route. They flew at altitudes of 6,000 to 8,000 feet and at an initial speed of 130 knots, when they were heavy with fuel. Their speed increased to about 160 knots as their load lightened, near Hawaii. The heaters were turned off shortly after takeoff to conserve fuel which did not contribute to the aircrew's comfort in the early morning cold. And, in addition, the C-123s lacked autopilots and had to be entirely hand-flown, a factor which contributed to fatigue.

The time en route from Travis to Hickam for the first four aircraft was sixteen hours and thirty minutes. The plane with the least amount of fuel remaining on arrival at Hickam had 3,000 pounds, or enough for about two more hours of flight. This proved the C-123 to be far more capable than had been thought. On the following day, the other two spray aircraft made the crossing in seventeen hours and thirty minutes without further difficulties.[9]

The flight departed Hickam for Johnston Island at 0800 Hawaii time on December 3. After a short refuelling stop, they proceeded to Wake Island. During aircraft inspections there, crewmembers discovered that a cylinder on one engine of the lead aircraft would have to be replaced. Because the necessary aircraft mechanics and spare parts were with the flight, they accomplished the cylinder change in record time. On December 5, the deployment leg between Wake and Guam was traversed without incident. At 0830 on the morning of December 6, the flight took off on the final segment of its journey, Guam to Clark AFB in the Philippines. Some three hours after takeoff, an oil leak developed in the number two engine of the lead aircraft. The crew was able to keep the oil supply in the affected engine at a safe level by using the oil replenishment system installed in the cargo compartment. All six C-123s landed in formation at Clark at 1600 hours on

December 6. They were to remain for a month awaiting orders to enter South Vietnam.[10]

Although the delay in the Philippines was frustrating, Captain Marshall used it to advantage. He obtained an area near the coast to practice spray patterns. Chemicals were not used on these practice runs. Some members of the detachment made trips to Saigon in other aircraft to inspect facilities and make plans for beginning operations there. Also during December 1961, a separate operations plan was published for the aerial spray operation, bestowing upon it the name Project Ranch Hand. At this time Ranch Hand's formal organizational title was Tactical Air Force Transport Squadron Provisional 1.[11]

While the aircraft waited at Clark for clearance to enter South Vietnam, high-level officials were still deciding whether their entry would be overt or covert, and how to handle the public affairs aspects of the operation. Although the final Defense Department recommendation[12] upon which President Kennedy had based his decision authorizing a defoliation operation[13] called for the overt approach, Secretary McNamara continued to hold open the option of disguising the defoliation program as a South Vietnamese operation. In a meeting with the Joint Chiefs of Staff on November 27, 1961, McNamara had informed the Chiefs of his recommendation to the President that the defoliation program be approved. He had directed them to proceed with planning based on the assumption that the South Vietnamese would conduct crop destruction missions using their own helicopters and that U.S. Air Force aircraft and crews would fly defoliation missions to remove jungle cover. At the same time, he had told the Joint Chiefs to develop an alternate plan whereby the defoliation missions also would be flown under South Vietnamese auspices with their markings on the aircraft and a South Vietnamese officer on the crew as the ostensible "aircraft commander." He had, in addition, directed that no publicity be given to U.S. participation in defoliation or crop destruction operations.[14]

In a message dated December 3, Ambassador Nolting in Saigon continued to recommend that the Ranch Hand aircraft carry civilian markings and their crews wear civilian clothes. His recommendation anticipated political problems with the International Control Commission (ICC) established under the Geneva Accords of 1954. The ICC had the authority to inspect shipments of military equipment entering South Vietnam. A shipment of 15,000 pounds of cacodylic acid (blue*) and 20,000 gallons of pink* and green* herbicides for use in crop destruction had by this time arrived unannounced in Saigon by military aircraft, and had bypassed ICC inspection. A

*See Appendix 2, Table 1, p. 199.

large sea shipment could not be hidden from the commission's scrutiny. Ambassador Nolting was concerned that when the shipment of chemicals for use in defoliation arrived by commercial ship consigned to the MAAG, he would be unable to fit it under an existing ICC credit or justification of title. He therefore recommended that these chemicals be manifested as civilian cargo consigned to the United States Operations Mission (USOM) in South Vietnam, exempting them from inspection. "Civilian" aircraft and crews would, he felt, be necessary to maintain consistency with "civilian" chemicals. He noted that both MAAG and USOM favored this course of action.[15]

The public affairs aspect of the Ranch Hand operation also troubled other high-level policy makers. On December 1, Brig. Gen. Edward Lansdale, an advisor to the Secretary of Defense, penned a warning addressed to Secretary McNamara and Deputy Secretary Gilpatric in which he cautioned them about the potential adverse publicity which could be generated by the planned defoliation operation in Vietnam. Lansdale was concerned about the lack of a " . . . sound information foundation to assure public support. . . . " He noted that during the Korean War, the communists had been able to convince many people around the world that the U.S. had engaged in biological warfare even though that charge was without foundation. In the case of defoliants in Vietnam, he pointed out that the U.S. would admit to spraying a chemical from the air which kills something (plants) and would therefore be vulnerable to a more serious psychological attack, very likely accompanied by unfavorable reaction from the U.S. media.

Lansdale felt that the existing plan—to have President Diem and his government announce that South Vietnam had asked the United States to spray defoliants—was not strong enough. He predicted that this approach would not be effective in the U.S., among allies, or elsewhere in the world. Diem's image as a " . . . cornered and power-mad dictator . . . " made such a request from him an insufficient public justification for the program. General Lansdale concluded his memorandum by suggesting that either he or a working group from the Department of Defense set about immediately to plan " . . . effective psychological support . . . " for the defoliation program. In his opinion there were good reasons for using defoliants and they should be presented, allowing the U.S. to undertake the defoliation program with much more firmness.[16]

Three days after Lansdale wrote his memo, Eugene M. Zuckert, the Secretary of the Air Force, sent a letter to Secretary McNamara expressing similar sentiments. Secretary Zuckert told the Secretary of Defense that he was " . . . seriously concerned . . . " about the lack of a specific assignment of responsibility for the development of cover stories for some of the planned or contemplated Vietnam operations. He mentioned specifically the current preparations for the defoliation operation which had resulted in ad hoc and uncoordinated public statements. Like Lansdale, he cited the

biological and chemical warfare implications of the Ranch Hand operation which the communists were already exploiting and stated his belief that " . . . we are dealing with a high degree of psychological warfare . . . ." Secretary Zuckert noted that his staff had talked with General Lansdale and William P. Bundy, the Deputy Assistant Secretary of Defense for International Security Affairs, who both agreed that the public relations aspect of the defoliation program was inadequately covered. He closed his letter by calling for a well-developed plan with a clear point of authority responsible for preventing the release of conflicting stories.[17]

On the 12th of December, a memorandum sent to William P. Bundy by Philip F. Hilbert, the Deputy for Requirements Review in the Office of the Under Secretary of the Air Force, indicated that the Air Force position on the manner of introducing Ranch Hand aircraft had hardened against the covert approach. Mr. Hilbert noted that "we" (presumably the civilian leadership of the Air Force) had been disturbed by Ambassador Nolting's December 3 message recommending the airplanes be introduced bearing civilian markings with the crews wearing civilian clothing. It would be possible, Hilbert conceded, for the U.S. to transfer title to the aircraft to the South Vietnamese or to develop some other cover, although the unique nature of the spray-equipped C-123s would clearly indicate that they had come from the U.S. Air Force. However, Hilbert maintained, " . . . the status of the crews in these circumstances would require considerable thought to insure that adequate protection both to the U.S. and to the individual was provided . . . ." In regard to spraying and transport activities, the Air Force position was: " . . . we believe that the C-123 units can best be used in an overt role in which there is no question of the status of crews or aircraft . . . ." Air Force wishes were heeded, for, on December 14, 1961 a joint State-Defense message announced that " . . . the identity of United States crews and aircraft participating in the spraying operations of the defoliation program will not be disguised . . . ."[18]

The question of the covert or overt status of the Ranch Hand aircraft and crews had been settled, but Ambassador Nolting's problems with the ICC still had to be addressed. On January 4, 1962, Deputy Secretary of Defense Gilpatric responded to Secretary Zuckert's letter and set out the future Defense Department policy covering public relations and security aspects of Vietnam operations. He stated that the United States and the South Vietnamese had a " . . . good, legally sound . . . " public justification for challenges to the increased level of U.S. military aid. This justification was that North Vietnam had committed acts of aggression against South Vietnam in flagrant violation of the Geneva Accords and that the United States was responding to South Vietnamese requests to assist it in legitimate self-defense measures. Accordingly, Secretary Gilpatric informed the Joint Chiefs of Staff and the Secretaries of the Army, Navy, and Air Force that future arrivals of U.S personnel and equipment would not be

announced by the South Vietnamese government to the ICC; nor would the United States admit that the Geneva Accords were being violated. American officials would respond to questions with the following statement:

> The United States has acceded to GVN's request for expanded aid in men and material and is determined to help preserve its independence. This is the sole objective of the United States. The United States will terminate these measures as soon as North Vietnam ends its acts of aggression.[19]

Secretary Zuckert's concern over the lack of a central point of responsibility for developing cover stories or public explanations for U.S. activities in Vietnam was answered by the designation of the Chairman of the Joint Chiefs of Staff as the official responsible for such matters, in coordination with affected Service Secretaries and the Assistant Secretary of Defense for Public Affairs. However, the Secretary of Defense would have to approve all proposed cover stories, explanations, statements of no comment, or combinations thereof. Thus, defoliation program concerns led to a restatement of the U.S. policy toward the Geneva Accords, the removal of ICC inspection power over shipments of U.S. military personnel and equipment, and the designation of a central point of authority for developing cover stories for U.S. operations in South Vietnam.[20]

On December 4, 1961, the Secretary of Defense met with the Joint Chiefs of Staff and set December 15 as the target date for beginning defoliation operations. At the same time, he granted his prior approval for the defoliation of "key routes," with the proviso that CINCPAC submit detailed plans and the Joint Chiefs approve them. Secretary McNamara, however, asked to be informed when these "key route" plans were submitted and approved.[21]

In addition to the previously discussed problem of developing a public relations approach to the Ranch Hand program, delays encountered in shipping chemicals to South Vietnam and producing a final target list kept the Joint Chiefs from meeting the target date. The shipment of the chemicals proved to be the most formidable obstacle to immediate commencement of spray operations. Twenty thousand gallons of pink and green herbicides and fifteen thousand pounds of cacodylic acid were already in Saigon. They had been sent for use in a crop destruction operation which waited for President Kennedy's approval and which could not then be conducted because that year's rice crop had already matured in the target areas. The Defense Department was procuring additional chemicals for Ranch Hand use in the defoliation of Viet Cong base areas, border regions, and transportation routes. These chemicals, 80,000 gallons of pink and 128,000 gallons of purple, combined with the shipment earmarked for crop destruction, cost about $2.5 million, or about $11 per gallon.

The acquisition of defoliants occurred on an expedited basis. As rapidly as truckload lots accumulated, shipments left the factories for the docks at Oakland, California, where port workers loaded 111,000 gallons of purple and 49,000 gallons of pink on the SS *Sooner State* which sailed for

Saigon on December 15, 1961 and arrived on January 8, 1962. The remaining chemicals, 17,000 gallons of purple and 31,000 gallons of pink, were loaded on the USNS *S.O. Bland* which had a sailing date later in December. The drums carried no military markings and were consigned only to "Country 77," a shipping designation for Vietnam.[22]

The option of airlifting some of these defoliation chemicals received consideration for a time. Headquarters, USAF alerted the Military Air Transport Service to ready twenty-five C-124 Globemaster transports to airlift, over the weekend of December 16–17, the chemicals awaiting shipment on the *Bland*. The airlift, however, was not ordered, perhaps because final mission plans for the use of the chemicals had yet to be developed and approved.[23]

On December 16, 1961 Secretary McNamara held a conference in Hawaii with Pacific area military commanders. The conference provided him with another opportunity to examine Ranch Hand preparations and make further decisions affecting the operations. Background documents prepared for this conference noted that Thirteenth Air Force and the Ranch Hand detachment had been alerted and were capable of beginning defoliant operations in South Vietnam within 24 hours of receiving orders to do so. General McGarr, head of the MAAG in Saigon, informed Secretary McNamara during the conference that a joint U.S.-Vietnamese planning committee was selecting key routes to be defoliated and expected to complete its work by December 20. Vietnamese authorities had designated one individual from the J3 (operations) section of their Joint General Staff (JGS) to work with U.S. officials to develop detailed plans, and an initial meeting had taken place on December 8. He noted that the development of a final plan was being "aggressively pursued."

McNamara explained that the defoliants would be used initially in road clearing because the chemicals presented a "ticklish" problem and road clearance offered the least potential trouble. He stated his desire to see the project get underway quickly, but he did not think it would be necessary to airlift the defoliants. Secretary McNamara also observed that he would be liberal in interpreting the phrase "key routes." Defoliants could be applied, he said, around ammunition storage sites and Jungle Jim operating locations as well as along roads and trails. He anticipated quick approval of specific defoliation plans once they were submitted.[24]

Obtaining the final approval for the initial defoliation missions was not as simple a matter as Secretary McNamara had indicated in his meeting with the Joint Chiefs on December 4. Admiral Felt forwarded the plan to the JCS on December 28, 1961, and the Chiefs added their approval in a memo to the Secretary of Defense on January 2, 1962. They noted that an implementing message was ready for dispatch upon the receipt of his approval and notice of final interagency coordination by the Assistant Secretary of Defense for International Security Affairs. The plan as finally approved by the Departments of State and Defense called for defoliating areas to a depth

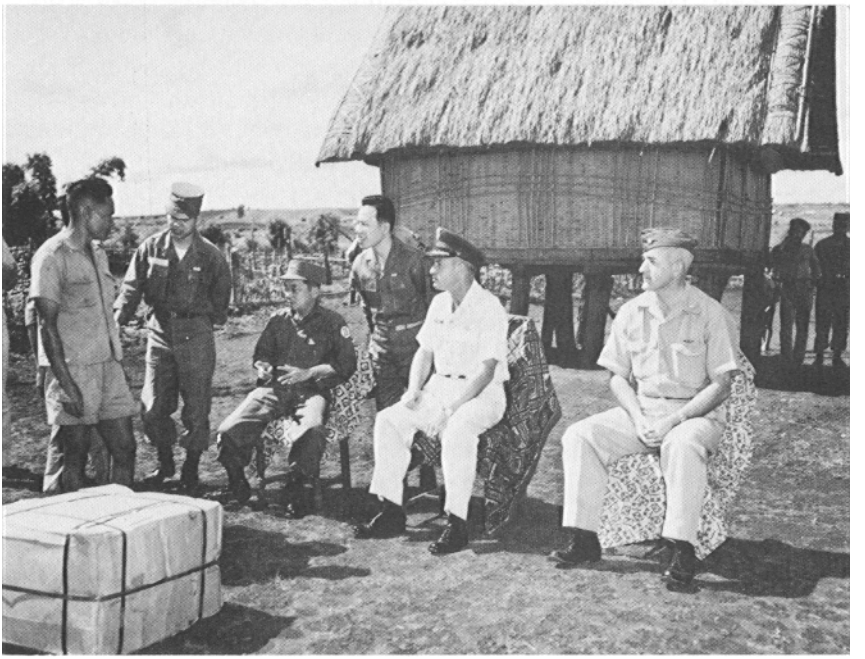
of 200 meters on both sides of about 300 miles of strategic roads north and northeast of Saigon. The ultimate goal was to reduce the Viet Cong presence in Zone D, one of their most secure base areas. By clearing vegetation along these roads, the potential for ambushes would lessen, thereby opening lines of communication.[25]

Secretary McNamara did not approve the plan as routinely as he had indicated earlier. Instead, he sought President Kennedy's concurrence. Severely paring the proposal, on January 3, 1962, Kennedy authorized limited operations of an experimental nature against separate targets which together comprised about 16 of the almost 60 miles along Route 15 between Bien Hoa and Vung Tau. Thus, the last barrier in Washington blocking the start of the Ranch Hand program fell, but the way this last decision was reached demonstrated again the extreme caution toward the use of defoliants initially displayed by leaders at the highest levels of American government.[26]

The directive to deploy three of the six Ranch Hand C-123s to Saigon without delay reached Clark in the early hours on January 7. At 0900 that same day, the aircraft departed the Philippines, arriving at Tan Son Nhut outside Saigon at 1630 in the afternoon. The crews parked the Ranch Hand planes in a secure fenced area on the field, sharing the space normally occupied by President Diem's personal aircraft. They then settled in at the field as, initially, all Ranch Hand personnel were restricted to the confines of Tan Son Nhut and quartered in an on-base "tent city" near the runway.[27]

Final preparation for the first missions occupied the next several days. On the night of January 8, the *Sooner State* arrived at Saigon with the chemicals to be used on the road clearing missions; off-loading of the drums began on the 9th. Photo reconnaissance missions along Route 15 during these two days double-checked target information previously obtained from maps and ground surveys. Ranch Hand and VNAF pilots received briefings on the 9th to lay the basis for teamwork and coordination during the upcoming spray missions. Also on the 9th, province chiefs and representatives of interested South Vietnamese government agencies held a meeting to review plans for warning the local population and countering Viet Cong propaganda. On the 3rd, Secretary of State Dean Rusk had cabled instructions to the American Embassy in Saigon to " . . . make no advance announcement other than local warnings, in low key, to population which will witness process. . . . " The South Vietnamese maintained that they would need three days to psychologically prepare the people in the target areas.[28]

In spite of Rusk's wishes, the South Vietnamese government released the following announcement on January 10, and it appeared the next day in South Vietnamese newspapers:

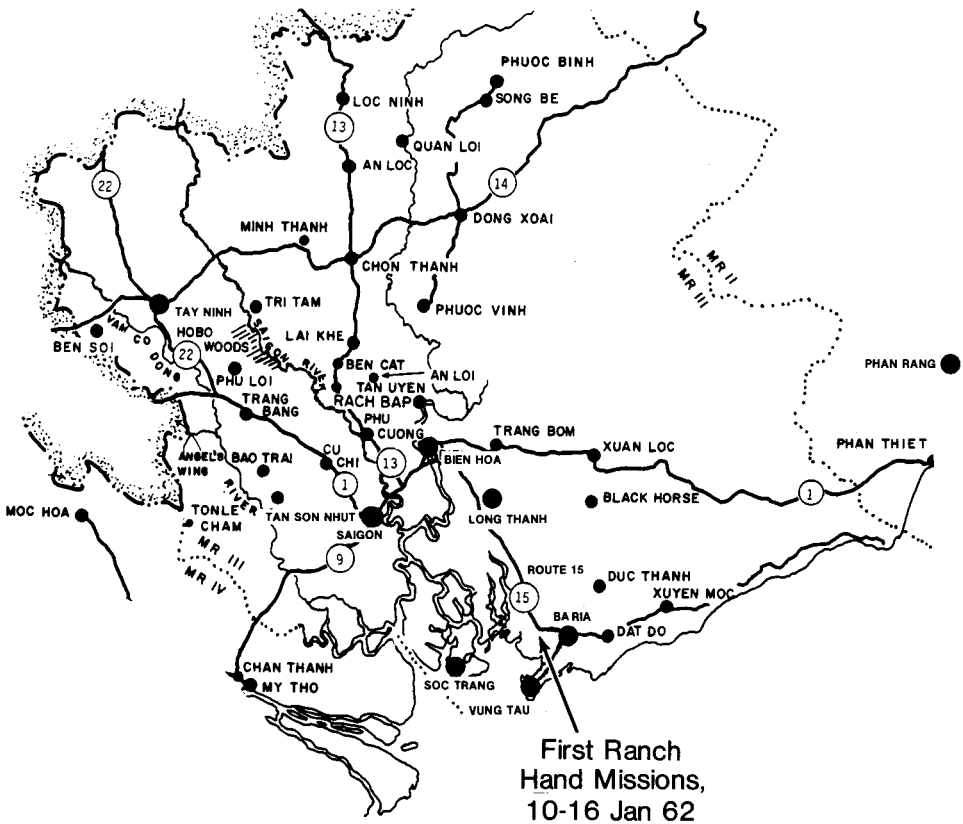


Top: Sec. Zuckert congratulates Gen. LeMay on his appointment as Chief of Staff, May 22, 1961; bottom, l. to r: Col. Manh, Gen. Anthis, and Col. Rogers confer with Montagnard province chiefs.

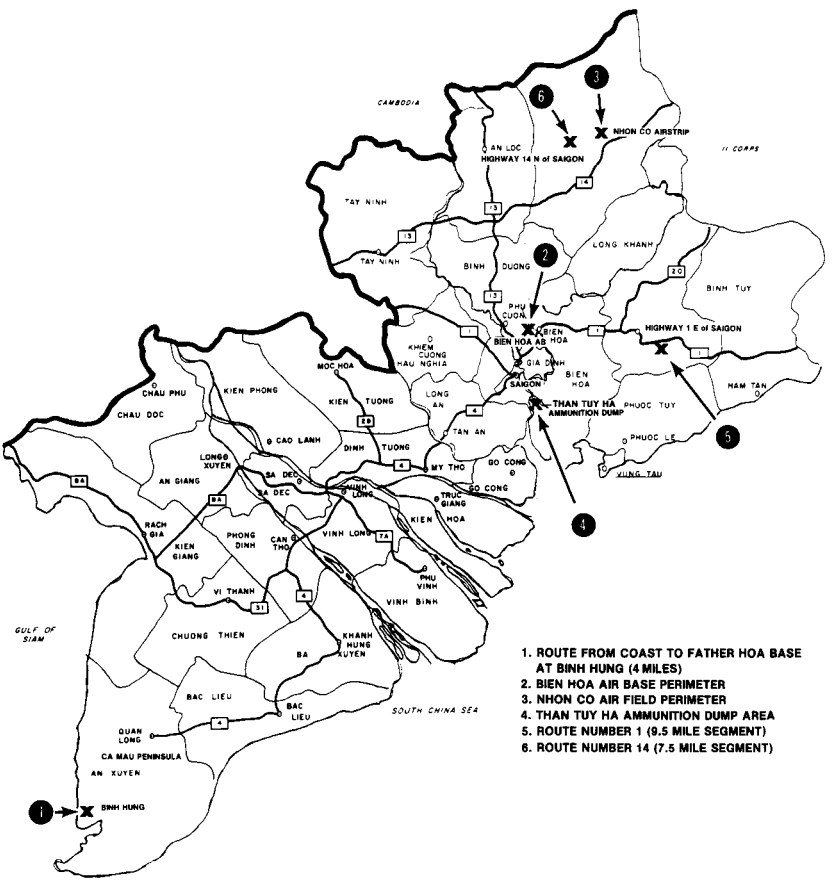
> SAIGON (VP)—The Republic of Vietnam today announced plans to conduct an experiment to rid certain key communications routes of thick, tropical vegetation. U.S. assistance has been sought to aid Vietnamese personnel in this undertaking.
>
> The purpose of this operation is to improve the country's economy by permitting free communications along these routes and by making additional land available for cultivation and other uses. In addition, it will facilitate the Vietnamese Army's task of keeping these avenues of communication free of Viet Cong harrassments.
>
> Commercial weed-killing chemicals will be used in experiments. These chemicals are used widely in North America, Europe, Africa, and the USSR for such purposes as ridding corn fields of weeds, renovating weed-infested grazing pastures and clearing irrigation ditches.
>
> The chemical will be supplied by the United States at the request of the Vietnamese Government. The Government emphasized that neither of the two chemicals is toxic, and that neither will harm wild life, domestic animals, human beings, or the soil. There will be little, if any, effect on plants outside the sprayed strip.
>
> If the results of this initial operation are satisfactory, extensive operations will be conducted to clear roads and railroads linking key cities of Vietnam. Clearance of tropical growth along these routes will ease greatly the task of maintaining road systems and railroad beds and will permit the construction of new roads.[29]

Ranch Hand pilots flew familiarization flights over the target areas along Route 15 on January 10 and 11 to determine specific checkpoints for precision in turning the spray on and off so as to avoid inadvertently spraying crops. The first defoliant was actually released from an Air Force C-123 during one of these flights on January 10. On January 9, Dr. James W. Brown, a scientist from the U.S. Army Chemical Corps Biological Laboratories at Fort Detrick, Maryland, who was responsible for the scientific aspects of the early stages of the defoliation program, had asked Brigadier General Rollen H. Anthis, the commander of 2d ADVON (Air Force headquarters in South Vietnam), to authorize a mission the next day. Dr. Brown felt that a functional pretest would be necessary before formally beginning the test series because neither the purple defoliant nor the C-123 with the Hourglass spray system had been used in Vietnam before, nor had a spray-equipped C-123 been used to deliver this specific chemical mixture. That afternoon Air Force personnel loaded four drums of purple herbicide (about 200 gallons) on one of the Ranch Hand C-123s for a flight the next morning. The spray target was north of Route 15, adjacent to a swath which a VNAF C-47 had sprayed with pink on December 29. The flight took place as planned on the morning of January 10, 1962, with the Ranch Hand C-123 spraying less than the full 200 gallons on the target. The effect of the spray was later rated as poor, probably because the spray deposit was sublethal. The purple herbicide, however, did dissolve the rubber seals in the spray system, requiring their replacement with neoprene seals which were unaffected by the chemical. These familiarization flights left the Ranch Hand aircraft and crews ready to begin formal operations on the 13th.[30]

FIRST RANCH HAND MISSIONS 10-16 JAN 1962



RANCH HAND TARGETS 14-17 FEB 1962



1. ROUTE FROM COAST TO FATHER HOA BASE AT BINH HUNG (4 MILES)
2. BIEN HOA AIR BASE PERIMETER
3. NHON CO AIR FIELD PERIMETER
4. THAN TUY HA AMMUNITION DUMP AREA
5. ROUTE NUMBER 1 (9.5 MILE SEGMENT)
6. ROUTE NUMBER 14 (7.5 MILE SEGMENT)

Capt. Carl Marshall and Capt. William F. Robinson, Jr., flew the two missions along Route 15 on January 13, 1962 which formally inaugurated the Ranch Hand program. They sprayed the first load between 0805 and 0825 from an altitude of 150 feet at an airspeed of 130 knots. The tank discharged its 960 gallons of purple herbicide in a total of 490 seconds of actual spraying time, for a flow rate of about .8 gallons per acre. The distance between flight centers (swath width) was 500 feet for the first flight, but the crew decreased this to 400 feet for the second flight because the heavy herbicide sank faster than expected, reducing the width of the area on the ground covered by a single spray application. The narrower swath width prevented gaps between sprayed areas. Captains Marshall and Robinson delivered the second load between 0940 and 0955 using a different C-123 and a higher pump pressure. This time the total "spray-on" time to expend the 960 gallons was 450 seconds, resulting in a flow rate of about 1.05 gallons per acre. During this run, the pilot of an observation plane flying slightly above the spray aircraft reported that some of the spray was rising rather than sinking to the ground—it was being deposited on his windshield. The sun had been up long enough to warm the air near the ground, disrupting the early morning temperature inversion and generating thermal updrafts which dissipated the spray rather than allowing it to fall on the target vegetation. Dr. Brown and the Ranch Hand personnel were well aware of the need to spray only during inversion conditions which lasted from shortly before sunset to shortly after sunrise, but they evidently had difficulty, initially, in getting this point across to some of the other U.S. officials in South Vietnam.[31]

Immediately, 2d ADVON reported these first two missions as completely successful, at least from a spray delivery standpoint. It would take time to determine the effect of the defoliant on the target vegetation. In ideal weather, the Ranch Hand pilots encountered no problems in acquiring the targets, enabling them to dispense the defoliant precisely over the areas previously designated by the Vietnamese authorities. ARVN armored vehicles patrolled the entire length of Route 15 during the spray operations but reported no Viet Cong ground fire. In addition, VNAF AD-6s provided fighter cover for both sorties. A Farm Gate SC-47 dropped 65,000 leaflets along Route 15 and made voice broadcasts over the towns of Baria and Long Thanh. Vietnamese observers, photographers, representatives from the MAAG, and Dr. Brown were passengers on these first missions. As on future spray missions, a Vietnamese was on board as the "aircraft commander," but he exercised no real authority.[32]

The first series of Ranch Hand missions along Route 15 continued for three days, and 2d ADVON reported them all as completely successful. As on the first day, armored vehicles patrolled Route 15 and VNAF AD-6s provided fighter cover; they noted no enemy military activity. The mission on the 16th completed the initial authorized spray work which, in ten sorties, used 7,920 gallons of herbicide and covered 6,920 acres. Within hours of the completion of the last mission, Admiral Felt dispatched a message to

General McGarr in Vietnam informing him that " . . . Wash[ington] D.C. approval necessary before carrying out any defoliant operations beyond those currently authorized. . . . " Ranch Hand was again under very tight high-level control.[33]

The precision required on Ranch Hand missions had highlighted the lack of cartographic information in Vietnam. Old and inaccurate, the small-scale maps made it difficult for Ranch Hand pilots to identify precisely spray-on and spray-off points—a crucial necessity if damage to civilian crops and rubber plantations were to be avoided. To fill this need, Ranch Hand requested 1:25,000 photo coverage of all target areas. RF-101 Voodoo reconnaissance planes flew these photo missions, landing at Tan Son Nhut and providing one copy of their film to Ranch Hand while sending another to Japan for use in making permanent maps.

First Lieutenant Marcus B. Keene, Jr., prepared mosaics of the general target areas from these aerial photos. A representative from the South Vietnamese Joint General Staff took the mosaics to the province chiefs responsible for the areas under consideration. The various province chiefs then marked on the photos the areas they wanted sprayed and the areas they did not want treated with herbicides. Because the province chiefs wanted to avoid damage to their agricultural areas, the Ranch Hand spray missions, especially along roads, were "choppy" and composed of alternate strips of treated and untreated areas. From the marked photos, Lieutenant Keene produced sets of coordinates defining the targets, which the Air Force section of the MAAG then forwarded to higher level commanders for final approval.[34]

The responsibility for flying the C-123 during the crucial spraying part of each mission was shared between the pilot and the copilot. The pilot had control of the switches which started and stopped the spray and which dumped the load of herbicide in an emergency. The responsibility of the aircraft commander on these missions was great—only a few days were needed before the action of the herbicide showed exactly where the load had been delivered there could be no doubt whether the spray had been on or off the target. The copilot was primarily responsible for handling emergencies, such as determining the malfunctioning engine in case of an engine failure, applying power to the good engine, and shutting down the bad one. Considering the low altitude at which Ranch Hand flew, the copilot's reaction in such an emergency had to be immediate and correct the first time; there would be no chance to rectify a mistake. The copilot also had to anticipate pull-ups at the end of each spray run and apply the necessary power for a turn. During the spray run, he kept the airspeed at 130 knots to achieve the planned herbicide application rate.[35]

The role of the South Vietnamese "aircraft commander" was not so clear. He had no actual authority over the mission, and the Ranch Hand crews felt he was carried solely to enable the U.S. to state in the event of criticism that the spray program was "their doings, not ours." At first, the

Ranch Hand personnel thought their Vietnamese "aircraft commander" was a rated pilot, which would have been consistent with his official role. However, on one mission, Captain Marshall, after using much persuasion, coaxed one of them into the left seat so that the Vietnamese could get an idea of what it was like to fly the C-123. His erratic handling of the controls soon convinced the American crew that he was not a pilot, and they subsequently learned that the VNAF had been sending them navigators to fill the U.S. requirement that a Vietnamese be on board for each mission. Later,the VNAF sent anyone who happened to be available, whether officer or enlisted.[36]

The conditions under which Ranch Hand operated at first can best be described as ad hoc. Nothing followed established procedures and standards familiar in the U.S., and there was a great deal of improvisation. Coordination with Farm Gate pilots took place at the Majestic Hotel in down town Saigon for want of a better place at Tan Son Nhut. Current intelligence on enemy emplacements was seldom available to Ranch Hand before their missions, and weather services weren't much better. Major Hagerty recalled landing at one of the fields outside Saigon and meeting an Air Force weather observer who had spent his whole tour in Vietnam without any equipment. When they touched down the weather observer questioned them about the winds and visibility they had experienced and the clouds they had encountered. Then, when the Ranch Hand crew was ready to depart, the weather observer gave them a weather briefing based upon the best information he had, which was simply a recapitulation of what the crew had told him when they landed.[37]

Ranch Hand's living conditions were also somewhat haphazard. The officers remained in the on-base tents for about a week before they were allowed to move downtown. Collectively, they rented an apartment building near the Cho Lon area of Saigon for their quarters. The enlisted men remained at Tan Son Nhut. Off base, Ranch Hand personnel were allowed to wear civilian clothes and spend "green" U.S. currency on the local economy. Improvisation provided both conveniences and necessities. For example, the men fabricated their own washing machine out of a 55-gallon drum attached to the rear of a tractor. And, as no safes were available, Lieutenant Keene stored his extensive reconnaissance photo collection in empty aircraft parts containers which were kept under guard. To combat the intense heat, Ranch Hand crews sometimes improvised their own tropical flying gear from t-shirts and bermuda shorts.[38]

Ranch Hand was in the curious position of having many bosses—TAC, 2d ADVON, MAAG Vietnam, 13th AF, PACAF—but none who effectively supervised them. Because of the unique nature of their mission, low-level flying and the dispensing of chemical sprays, their immediate chain of command lacked the necessary expertise. As one favorable result, the Ranch Hand unit maintained its integrity and its personnel were not drawn off to work on other missions. However, because their actual work load was

light, only three or four hours on the few scheduled spraying days, some Ranch Hand pilots tried to obtain flying time with the Mule Train detachment which flew C-123s around South Vietnam on cargo missions.[39]

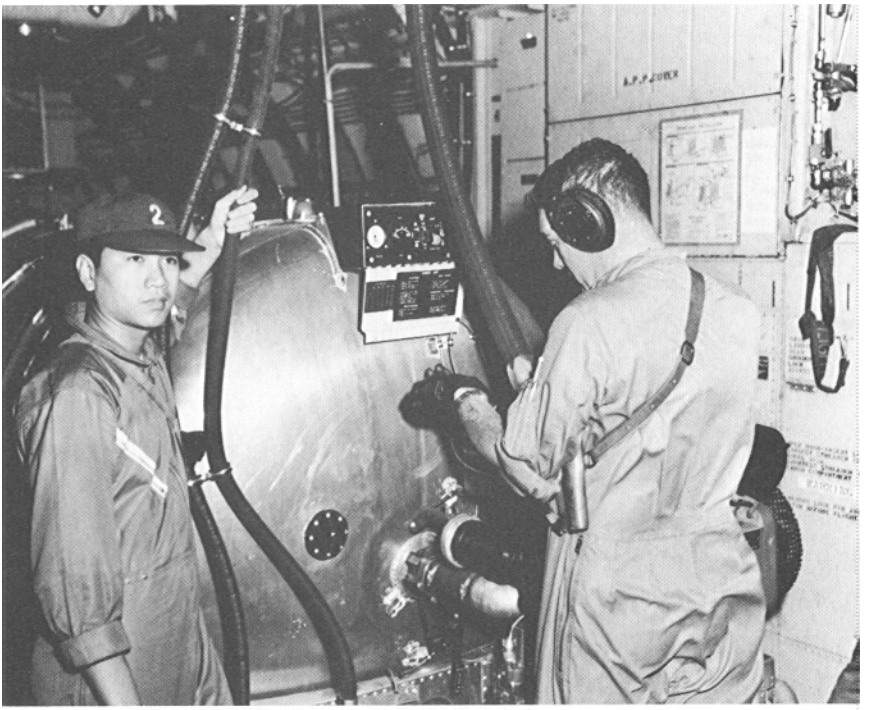
Although policies varied on the public release of information, the Ranch Hand mission was very sensitive. While a photographer from *Life* magazine had been invited to photograph some of the January missions, a photographer from *Time* created quite a stir when he took unauthorized telephoto shots of the planes in their secure parking area. It was impossible, however, to hide Ranch Hand's nature from people who had access to Tan Son Nhut. The vapors from the herbicide had killed the vegetation around their parking area, including two large flame trees next to their hangar. Such difficulties regarding the public information aspects of their job was compounded by the fact that not all of the members of the American military community in South Vietnam supported their mission. At a party given for Ranch Hand by Ambassador Nolting in about February 1962, an American Navy officer asked how they could manage to sleep at night knowing they were such "violent men."[40]

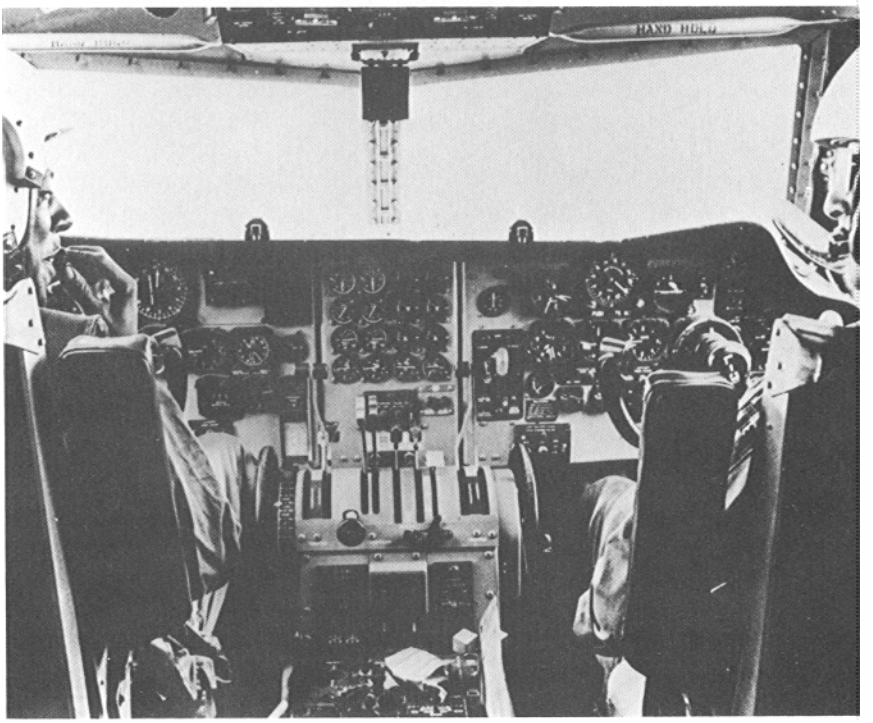
During the late-January break in operations, Ranch Hand pilots and crews used their available flying time to practice spray techniques and to become familiar with flying over the southern portions of Vietnam. Thirteenth Air Force also requested authority from PACAF during this lull to use the three Ranch Hand aircraft left at Clark for " . . . mosquito control and other operations in the Philippines as deemed advisable and necessary. . . . "[41] PACAF passed this request to CINCPAC, and Admiral Felt responded with a series of questions about how such operations would be funded, what precautions would be taken to minimize the possibility of claims against the U.S., and what effect the possible need to decontaminate the aircraft plumbing and spray system after mosquito control operations would have on the operational readiness of Ranch Hand aircraft for their primary herbicide mission. The Admiral also noted that Washington approval for resuming and extending defoliation operations in South Vietnam was expected, and that these new operations might require all six of the spray-equipped C-123s currently in the Pacific area.[42]

On February 2, 1962, the six became five as Ranch Hand lost one of its aircraft and crews during a training mission. The aircraft's crew, Capt. Fergus C. Groves, II, Capt. Robert D. Larson, and SSgt Milo B. Coghill, became the first Air Force fatalities in Vietnam. Their plane crashed in an inaccessible area near Route 15 between Bien Hoa and Vung Tau. Another aircraft which circled the crash site immediately after the plane went down reported that the "bad guys" were all over the wreckage. The search party had to be escorted to the crash site by a company of ARVN troops. Arriving they found that someone had removed the plane's spray nozzles and broken into the crewmembers' escape and evasion kits. There was no evidence of sabotage, engine failure, or hits by ground fire; the cause of the crash was never officially fixed. As a result of the crash, however, Thirteenth Air

Top: Dr. James W. Brown leads a team checking the results of defoliation in the jungles of South Vietnam, January 1962; bottom: an RF-101 Voodoo reconnaissance plane.

P. 41 (top): a Vietnamese officer (l.) and SSgt Milo B. Coghill, 346th Troop Carrier, Sq., operate a pump aboard a C-123 during a defoliation mission over South Vietnam; bottom: a Ranch Hand cockpit of a UC-123 aircraft in South Vietnam, 1967.





Force requested fighter cover by Farm Gate aircraft for all future Ranch Hand training missions. One of the three C-123s which had been left in the Philippines flew to Tan Son Nhut to return the Ranch Hand strength in South Vietnam to three aircraft.[43]

Two weeks earlier, on January 15, 1962, Secretary McNamara had convened his Pacific area military commanders in Hawaii for a second conference at which he gave instructions that the next phase of the defoliation program should be a very limited set of experiments to test herbicides and delivery vehicles in a representative variety of terrain and vegetation types encountered in South Vietnam. He wanted these new targets to be specific small areas, not 16 miles of roadway. It would be acceptable to proceed slowly in order to test all spray environments and gather data on the effects of defoliation on combat operations. McNamara tasked Admiral Felt with selecting the test areas and forwarding his recommendations to Washington for approval.[44] At the conclusion of the conference, Felt cabled General McGarr requesting a list of limited areas containing vegetation types which had not been sprayed during the operations along Route 15. CINCPAC emphasized, as had McNamara, that:

> . . . these additional operations are to be limited in scope and will be conducted solely for purpose of evaluating effectiveness defoliant against different types vegetation under varying conditions.[45]

The answer to this cable came from Vietnam within 36 hours, proposing seven additional areas for defoliation. The two targets heading McGarr's list were stretches of Highway 1 east of Saigon and Highway 14 north of the city. Spraying these two targets would strip the principal species of vegetation present in South Vietnam. The previous areas sprayed along Route 15 had consisted of scrub growth, palmgrove, mangrove, and scattered hardwood trees. The dense rain forest and moderate undergrowth along the Route 14 segment would provide vegetation typical of the plateau region, while the proposed stretch of Route 1 consisted mainly of uncanopied forest containing heavy undergrowth. McGarr also recommended five other areas. One, a mangrove forest in the far southern portion of the Ca Mau peninsula, would be cleared to provide a secure route from the coast to Binh Hung, the home base of Father Hoa—one of the few strong pro-government leaders in the Delta. (Father Hoa was a Catholic priest who had led a group of North Vietnamese to the South at the conclusion of the war between the French and the Viet Minh in 1954.) At that time, cargo had to be dropped to Father Hoa's forces by air, and defoliation would hopefully enable lighters to ferry supplies from ships off the coast without so great a risk of Viet Cong ambush. The other four vegetation enveloped targets were the rapidly expanding Bien Hoa Air Base (to be sprayed by VNAF helicopters), the ammunition dump at Than Tuy Ha, the two Cambodian border outposts at Dinh Tien Hoang and Bu Jamap (considered as one target), and the Nhon Co airstrip.[46]

Admiral Felt's response to this proposal indicated displeasure at the extent of the area to be covered. He noted that the total length of roads to be

cleared came to approximately 80 miles, and that this would be " . . . considerably beyond the program of 'very limited character' described by SECDEF at 15 Jan meeting. . . . " Also, he stated that he could not support initial test operations around outposts anywhere near the border with Cambodia. However, Felt was pleased with the targets selected in the Father Hoa area and around ammunition depots and airfields. He directed General McGarr to revise the proposal in order to select " . . . a few small segments of key routes which will provide the desired variety of growths and climatic conditions. . . . " He imposed a maximum of ten miles for each type of vegetation target.[47]

General McGarr revised his proposal according to these criteria. Admiral Felt concurred and forwarded a more limited plan to Washington for final high-level approval on January 24. By January 27 the plan had gained the approval of General Lemnitzer, acting for the Joint Chiefs, and William P. Bundy, the Deputy Assistant Secretary of Defense for International Security Affairs. However, the approvals of the Secretary of Defense and the President were still needed. Mr. McNamara rejected a draft memorandum for President Kennedy on January 30, because it did not clearly explain the necessity for expanding the experimental spraying program and because he wanted the comments of the Department of State included in the memorandum so that the President would not have to read two papers when one would do. His subordinates made these changes, McNamara added his approval to the plan, forwarding it to the President on February 2.[48]

In his letter to President Kennedy, Mr. McNamara noted that although the initial defoliation operations were over, a second spraying of the areas would be required three weeks after the first. It was too soon to tell how effective the defoliant had been. He also stated that no adverse public relations effects from the first series of tests had appeared in South Vietnam, and that reaction from foreign non-communist nations had been light. As expected, the media reaction in communist nations was hostile. On January 21, Radio Moscow accused the U.S. and South Vietnam of undertaking a chemical warfare program to destroy food. Radio Hanoi broadcasts on January 19 and 24 emphasized the use of toxic chemical sprays to destroy natural resources and crops. Radio Peking issued similar comments. Analysts viewed the communist reaction as the intensification of a propaganda theme begun as early as November 6, 1961.

Secretary McNamara recommended that President Kennedy approve the targets proposed by General McGarr and his staff, with the exception of the Cambodian border outposts and with the total length of areas to be cleared along Routes 1 and 14 reduced to 17 miles. He noted that the Department of State concurred in this recommendation. His justification was as follows:

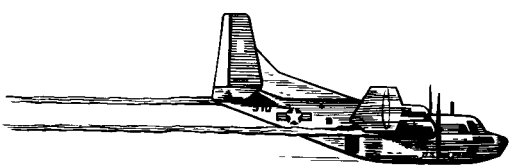
> The great variety of vegetation found in Vietnam includes species never treated in previous herbicide tests. The limited areas already sprayed do not include the variety of vegetation and conditions required for a full evaluation of

> the effectiveness of the chemicals employed and possible operational concepts for their use. It is important that we test all conditions of vegetation, as well as the effectiveness of defoliant techniques in specific situations, before proceeding with a larger scale program.[49]

Within a few days President Kennedy approved these recommendations, subject to the understanding that the ground rules for the new operations would remain the same as for the first set of targets. The letter communicating the President's approval did not elaborate on these "ground rules," but presumably the President meant to limit additional missions, to keep them experimental in nature, and not to extend them without his specific approval. The Ranch Hand detachment once again had been given a mission to perform, but its actions were still severely limited.[50]

Notice of this decision reached Vietnam on February 8, 1962, and the Ranch Hand crews flew the authorized spray missions on February 14–17. On the fourteenth, they sprayed a target along Route 14 which was approximately 10 miles long by 400 yards wide and totalled 1,300 acres. That same day they sprayed about 900 acres surrounding the Nhon Co airfield. Activity on the 15th consisted of spraying a stretch of Route 1 of the same dimensions and area as the target along Route 14 on the previous day. Father Hoa's area was sprayed on the 16th and 17th, with 2,700 acres covered the first day and 1,600 acres on the second. In all, these February operations took 12 sorties, used 154 drums of purple herbicide (about 8,470 gallons), and covered 7,800 acres. The weather was good for all missions, and no hostile activity was observed.[51]

With the exception of the Bien Hoa airfield and the Than Tuy Ha ammunition storage area which were to be treated by VNAF helicopters, the spray missions on February 17 completed the initial coverage of all the targets authorized by President Kennedy. Ranch Hand aircraft resprayed the areas along Route 15 on March 20 after which date herbicide operations were suspended for five months while the whole spray program was re-evaluated. Ranch Hand was entering an extended period during which its future was very uncertain.[52]



IV. Early Evaluations and Expanded Operations

Even before the early 1962 herbicide missions ended, American officials at high levels had expressed a great deal of interest in learning the effectiveness of this new chemical counterinsurgency tool. An important argument used in obtaining President Kennedy's approval for these operations had been that they were to be limited experiments. It was, therefore, not surprising that the evaluation of these first Ranch Hand missions received high priority. At the January conference held by the Secretary of Defense in Hawaii, Ambassador Nolting expressed his view that the most valuable potential contribution of defoliants to the war effort would be measured by their success in preventing ambushes. Secretary McNamara, on the other hand, felt that the evaluation of defoliation should address two major questions: first, what will defoliants do to the vegetation native to Vietnam under the variety of conditions found there, and second, what effects does defoliation have on operations?[1]

At the next meeting in Hawaii between McNamara and his Pacific area military commanders on February 19, 1962, the effectiveness of the defoliation program was again discussed. A message indicating that the program would be on the agenda passed from the Joint Chiefs to CINCPAC on February 12. The Chiefs stated that defoliant operations were receiving close scrutiny in Washington, and they asked Admiral Felt to send them a detailed report describing the effectiveness of various chemical combinations, types of foliage, and stages of growth. In addition, they requested a realistic appraisal of defoliation in combating the activities of the Viet Cong.[2] CINCPAC delegated the task of drafting this report to CHMAAG, Vietnam,* but the scheduled, conference took place before he could finish it.[3]

The February discussion in Hawaii concerning Ranch Hand began with a breifing by Maj. Gen. Charles J. Timmes, an Army officer from Vietnam

*On February 8, 1962, CINCPAC with the approval of his superiors established the U.S. Military Assistance Command, Vietnam (USMACV or MACV) as a subordinate unified command under his control. The Military Assistance Advisory Group, Vietnam (MAAGV) continued to exist until May 15, 1964, but it was made subordinate to MACV in advisory and operational matters. Therefore, after February 8, 1962, the Commander, United States Military Assistance Command, Vietnam (COMUSMACV) was the senior U.S. commander in Vietnam. However, for a time some messages and documents meant for the senior commander were addressed to CHMAAG, probably out of habit. Gen. Paul D. Harkins, USA, served as COMUSMACV from February 8, 1962 until 20 June 1964. On July 1, 1962, Maj. Gen. Charles J. Timmes, USA, became CHMAAG, Vietnam, succeeding Lt. Gen. Lionel C. McGarr, also an Army officer. See Maj. Gen. George S. Eckhardt, *Vietnam Studies: Command and Control 1950–1969.* (Washington: Department of the Army, 1974), pp 25–33, 42, 89.

who would later become Chief of the MAAG there. He reported that 90% to 95% of the sprayed mangroves along Route 15 had lost their leaves. Other vegetation was deteriorating, but since many plants were in their dormant season, the chemicals were less effective. The spray worked well on the mangrove because it grew in swampy areas where the availability of water in both the wet and dry seasons allowed it to grow constantly. Secretary McNamara asked General Timmes if the effect of the chemical on the dormant species should be considered "certain but slow" or simply "uncertain." The general replied that it was "certain but slow."[4]

After hearing this report, Mr. McNamara stated that he was dissatisfied with the results of Ranch Hand. He requested a complete technical report, including photographs before and after the application of the chemicals. This report, he said, should be prepared by a technician who could tell him exactly about the attempts, goals, and results. The Secretary also observed that the defoliation project, in his opinion, had not been managed very well. Although no one criticized the Air Force crews for their handling of the spray missions, General O'Donnell, the PACAF commander, stated that the spray program had been "a blooper from start to finish," presumably agreeing with Secretary McNamara's assessment of the program's management. McNamara emphasized that Ranch Hand was not a scientific experiment for scientific purposes but rather a program intended to affect military operations, and the report he had ordered should state the operational results of the missions.[5]

Ambassador Nolting raised one other topic at this meeting relating to the Ranch Hand program. He reported that the local people had lodged many complaints of damage to their trees and crops. The South Vietnamese had established a board to rule on these claims, but the Viet Cong were readily exploiting the situation and blaming the herbicide missions for any and all dying plants. The Ambassador noted that disallowed claims would antagonize the claimants. Investigations by that time had reduced claims for spray damage to 200,000 Vietnamese piasters (about $5700).[6]

Within a few days of this February meeting, ground reconnaissance revealed that little or no military advantage had resulted from the January defoliation missions along Route 15, and the U.S. advisors concluded that the trees would have to be destroyed for any useful effect to be achieved. Fighter planes were sent to drop napalm in an unsuccessful attempt to ignite the defoliated areas. The napalm canisters fell through the canopy intact and ignited, with no significant effects, only after hitting the ground. On the other hand, the crowns of the trees did burn when the canisters tumbled on top of the canopy and scattered their load of flaming napalm in the treetops. The main problem was that pilots could not consistently drop napalm canisters so that they would tumble on the canopy. Moreover, the fires which did start were not self-sustaining.[7]

Between the February and March meetings with the Secretary of Defense, Gen. Paul D. Harkins, COMUSMACV, issued a preliminary

evaluation of defoliation based upon detailed ground observation. He concluded that defoliation as yet yielded no military advantage. Improvements in horizontal visibility were negligible, in vertical visibility only slight. Observers noted that the majority of plants in the sprayed areas were alive with many hardy new shoots. Also, they saw some obvious damage to small garden plots belonging to the local Vietnamese, a development the Viet Cong were fully exploiting for its propaganda value. In light of the failure to burn defoliated areas, Harkins felt that hand clearing or bulldozers would have to be used in order to achieve results of any military significance.[8]

At about the same time that Harkins issued his evaluation, Dr. James W. Brown also produced a preliminary report summarizing his work for the Advanced Research Projects Agency (ARPA) on defoliation in South Vietnam covering mid-July 1961 to mid-February 1962. As a scientist, Dr. Brown's views reflected the technical aspects of defoliation and not the impact of the Ranch Hand program on combat operations in the sprayed areas. He concluded:

> The chemicals recommended for use, namely, the esters of 2,4-D and 2,4,5-T, are sufficiently active to kill a majority of species encountered in Vietnam if:
>
> (1) They are applied properly to the vegetation
>
> (2) They are applied during a period of active growth of the vegetation.[9]

He noted that missions flown by Air Force C-123s had proven that the chemicals would work effectively on actively growing mangrove trees in swampy areas, but that the dormant state of upland vegetation during the December-February dry season had seriously limited the effects of the herbicides. He also cited the lack of calibration of the C-123 spray equipment as a limiting factor in arriving at firm conclusions based on the test areas sprayed to date.

Dr. Brown expanded these views and provided much more background information in the two volumes he wrote on the early defoliation experiments after he returned to the United States. In these later volumes he cited factors he felt had impeded the conduct and evaluation of the tests. He included in those factors the limited expertise available in the Department of Defense on the subject of herbicides, the lack of knowledge among botanists about the species of vegetation encountered in Vietnam, the inhibition on observing the sprayed areas caused by the presence of the Viet Cong, and the timing of the missions with the South Vietnamese growing season. Dr. Brown cautioned that the greatest effect to be expected under any circumstances from chemical sprays would be similar to the condition of a U.S. hardwood forest in winter; that is, the leaves might be gone, but the trunks and branches would remain. Even this condition, he said, would be only temporary in the absence of repeated sprayings, because seeds would give rise to new plants in the defoliated areas, and understory plants which had not been killed would be able to grow rapidly in the sunlight previously blocked by the taller trees.[10]

Top: an Air Force photographer records effects of defoliation; bottom: a Vietnamese soldier inspects foliage after herbicide treatment.

Addressing future operations, Dr. Brown emphasized that defoliation spraying should only occur when vegetational growth had been active for at least three weeks, a recommendation he had made in January. He also set forth some objections to the idea of burning defoliated jungle. Forest fires, he said, were relatively rare events in South Vietnam. He pointed to the blazing crash of a Ranch Hand C-123 in February which burned the wreckage but would not spread to the unsprayed jungle. Similarly, a fierce fire in bulldozed debris at the edge of a sprayed area along Route 15 had not spread, casting doubt that even a sprayed forest would burn. Dr. Brown negatively cited the high relative humidity of South Vietnam in any attempt to ignite jungle. He lamented that the failure of attempts to start fires would probably lead to an unwarranted condemnation of the spray.[11]

An American intelligence advisor gave an interesting report on the effect of the February 1962 Ranch Hand missions on some of the local population in the Mekong Delta. During the period March 1-5, 1962, a group of 112 people surrendered to the South Vietnamese government in An Xuyen Province. Though all initially had been labeled as "communists," authorities later classified only nine as Viet Cong guerrillas. However, some other members of the group admitted that they had supported the Viet Cong by collecting supplies and growing crops for them. The District Chief in the area had announced the plan to employ defoliants, and the group, fearing effects they had observed from Ranch Hand missions, surrendered.[12]

An Air Staff team, headed by Gen. Curtis E. LeMay, the Chief of Staff of the Air Force, visited South Vietnam, April 16-21, 1962, including Ranch Hand organizations. They flew over one of the sprayed areas along Route 1, descending to about 100 feet for a close look with, as one participant remembers it, a total of 43 "stars" on board the aircraft. General LeMay was not overly impressed with the results he saw, but he did suggest further testing.*

Discussions with other officials in South Vietnam led General LeMay to conclude that there were divergent opinions on the success or effectiveness of the spray program. However, in President Diem, the general found a strong supporter of using anticrop chemicals against areas "known" to be completely dominated by the Viet Cong. Considering that experts on the subject had told him that the time was right for using the chemicals against crops, and in light of the availability in South Vietnam of the necessary chemicals, aircraft, and skilled crews, General LeMay recommended that an anticrop program should get underway immediately.[13]

In response to the February requests for a detailed report on the effectiveness of the Ranch Hand missions, a team selected by ARPA assembled

*On this same flight, Gen. LeMay tried to tune a charted radio beacon and was surprised to learn that it would only transmit if the plantation owner who operated it had decided to turn it on that day. This vividly illustrated to him the primitive condition of the navigational aids which Ranch Hand and other outfits had to use.

in South Vietnam in April to continue further research. The leader of this team was Brig. Gen. Fred J. Delmore, the head of the Research and Development Command, U.S. Army Chemical Corps. Also included were four scientists: two from the U.S. Department of Agriculture—Warren C. Shaw and Donald Whittam; one from ARPA—Levi T. Burcham; and one from the Chemical Corps—Charles E. Minarik. This evaluation team began its investigation on April 7, 1962 and completed its report on the 28th. General Delmore presented an eight-minute oral summary of his team's findings to Secretary McNamara, Admiral Felt, General Harkins, and other officials at the fifth regular conference between the Secretary of Defense and his Pacific area military commanders, at MACV headquarters in Saigon, on May 11, 1962. General Delmore gave a brief description of his team's mission and composition, concluding that "the report is technical in nature, and except as to technical feasibility, does not address itself to operational considerations."[14]

The team found three kinds of natural vegetation—evergreen forest, mangroves, and tropical scrub—growing in the important areas of South Vietnam. The evergreen forests typically contained 200 or more different types of plants per acre, ranging from trees ten inches or more in diameter and 90 to 100 feet in height to a dense understory of smaller trees and bamboo. Mangrove, by contrast, usually grew in dense, pure stands containing trees of the same age with diameters of ten inches or more and heights up to 60 feet. Tropical scrub, they found, was composed of many different kinds of vines, grasses, and other plants, growing densely, with bamboo as an important constituent. They noted, as had others, that most of the vegetation in South Vietnam grew actively only during the wet season and was relatively dormant at other times. Because of the importance of growth or dormancy of vegetation in determining the effectiveness of growth-regulating herbicides applied, Delmore's team stressed the need for a complete "target analysis" of each area contemplated for spray. They also observed that most vegetation in South Vietnam appeared to be more susceptible to herbicides than several species of oak and mesquite which had been the objects of successful herbicide spraying in the United States.

Although they did not criticize Ranch Hand's flying, Delmore's group pointed out some serious limitations in the equipment the unit had been using. Because the herbicide was more viscous than other fluids, such as insecticides, the spray equipment could only deliver one or fewer gallons per acre, whereas the team of researchers concluded that three gallons per acre would be required for consistent success in South Vietnam. Also, the size of the droplets, they surmised, was smaller than the optimum of 300 microns, resulting in an excessive loss of herbicide by drift and a poor distribution of spray on some targets. They strongly recommended modifying the spray equipment to increase the amount of herbicide delivered per acre.

Perhaps in keeping with Secretary McNamara's known affinity for numbers and statistics, General Delmore's team quantified their report of

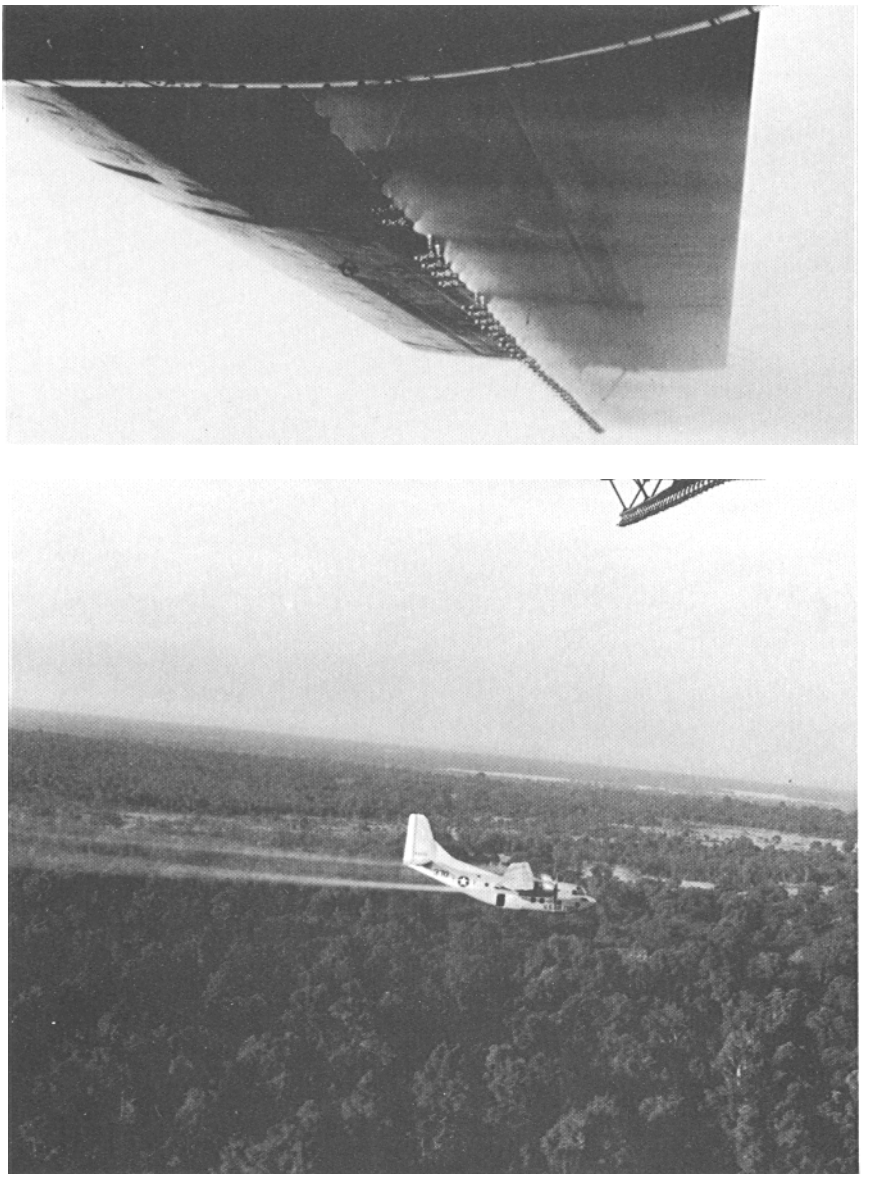
the technical effectiveness of herbicides on the target vegetation. They evaluated each target on the basis of five factors: defoliation, canopy kill, vertical visibility, horizontal visibility, and the distribution of herbicide. Each observer assigned a value of between zero (no effect) and 100 percent (complete effect) to each of the 21 target areas examined on each of these five evaluation factors. Then, the individual observations were averaged to arrive at a score for each target on each of the five factors. "A thorough and intensive evaluation from both air and ground . . . " was the basis for these scores. Of course, with no objective standards on which to base their numerical evaluations, these quantified measurements in reality were only subjective impressions expressed in numbers rather than words.

From the air, the team's average evaluation of defoliation, canopy kill, and vertical visibility was 80, while their average score for distribution of herbicide was 60. However, when they examined areas from the ground, their evaluation was lower. From ground evaluations, their average rating for both defoliation and canopy kill was 70; for horizontal visibility, 50; and for distribution of herbicide, also 50. The team reported one other statistic called "total target effectiveness," defined as the average of the other four scores. This summary measure from the air averaged 70, and from the ground it was 60. The team admitted that there were problems with the "total target effectiveness" figure since it resulted from a combination of unlike items.

In closing his presentation to Secretary McNamara, General Delmore summarized his group's recommendations. Among other things, they advocated a resumption of vegetation control* operations in South Vietnam after modifying the dispersal equipment to increase the volume of herbicide delivered. Also, they felt that specialists should be available to provide technical assistance on such matters as making a detailed target analysis of each area before spraying to insure that vegetation would be treated only when it was growing actively. They proposed an accelerated research program to investigate herbicide effectiveness and the use of additives; improve spray equipment; find out more about the tropical vegetation in the target areas; and develop better methods of disposing of vegetation killed by herbicides. All final field testing was to be done in South Vietnam. Finally, on the sensitive subject of crop destruction, the team "recognized" that food crops could be destroyed by herbicides on hand in South Vietnam but noted that other chemicals were available which could kill crops selectively.

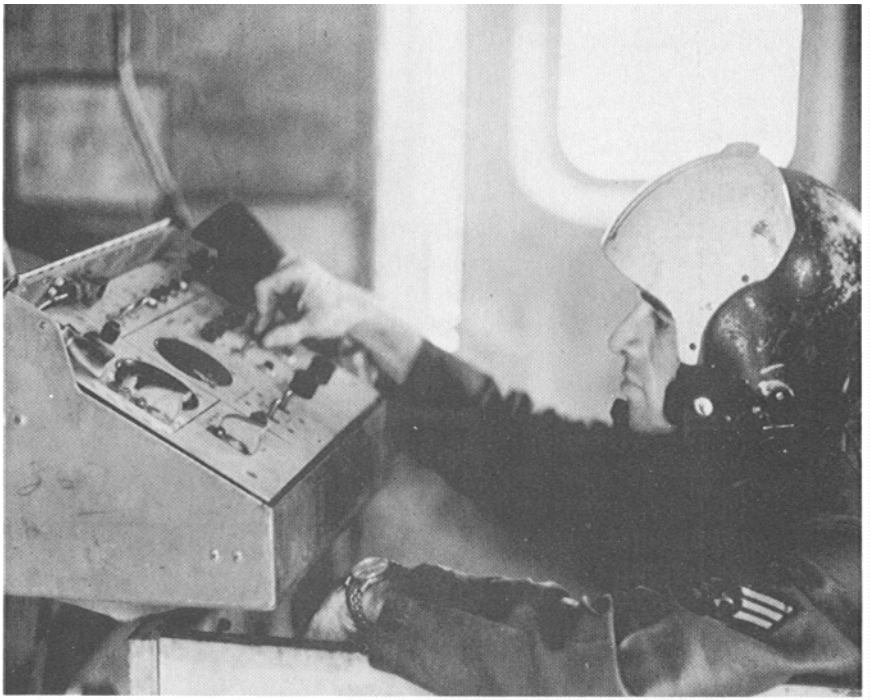
Secretary McNamara, thanking General Delmore for an excellent presentation, stated that this was the first time he had heard a clear explanation of the defoliation program. On the subject of the research program which the team had proposed, Mr. McNamara wondered if final tests should not be conducted in another country, such as Thailand. He also asked about the

*Technical experts preferred the term "vegetation control" as a more descriptive and accurate label than "defoliation." The vegetation was most often "controlled" by killing it.



Top: an insecticide spray boom on the wing of a C-123; bottom: a Ranch Hand aircraft on an insecticide mission.

P. 53 (top): a flight engineer operates spray console on a modified C-123; bottom: herbicide sortie.



cost of spraying, and General Delmore quoted the figure of $8 per gallon or $24 per acre, noting that crops could be destroyed at a lower cost by diluting herbicides with fuel oil.* Mr. McNamara requested General Delmore to forward his report with recommendations on defoliation and crop destruction to the Department of Defense, and he would then clarify the status and future of the program.[15]

The written report forwarded to Washington in response to Secretary McNamara's request expanded the information in the oral report. However, there were a few differences worth noting. Although General Delmore's oral presentation mentioned the evaluation of 21 targets, the written report showed data from eleven, only seven of which Ranch Hand had sprayed.

The written report clarified the fact that the effectiveness of herbicides —whether and how fast death could cause the plant to drop its leaves—depended on the particular species of plant. Many plants would defoliate upon atrophy of their leaves, but some would be less likely to lose their leaves when sprayed at certain times. The evaluation of herbicide application, Delmore's group cautioned, might have to wait from a month to a year after application. They also said that retreatment, approximately on an annual basis, would be necessary with purple herbicide to maintain the effect. In any event, they made the clear statement that: "No herbicides or other chemicals or mixtures of chemicals are known which will cause rapid defoliation of vegetation containing a wide variety of different species."[16]

Concerning problems encountered with the aerial dispersal equipment the evaluation team erroneously stated that none of this equipment was specifically designed for herbicide application or for liquid application at rates greater than approximately one gallon per acre. They were probably unfamiliar with the history of the MC-1 Hourglass spray unit carried in the Ranch Hand C-123s, for, as discussed in Chapter I, designers had built the Hourglass specifically to spray 2,4-D and 2,4,5-T. However, they were correct in stating that such high flow rates exceeded the designed capability of the unit.[17]

The Delmore team devoted an appendix of their written report to the discussion of chemical destruction of Viet Cong food crops. Perhaps influenced by the anticrop research at Fort Detrick and other places in the 1950s, they considered it an attractive option and summarized their view:

> Destruction of Viet Cong food crops in the field could be one of the most effective means of defeating the enemy. The Viet Congs [sic] currently are living on food crops grown in the areas that they control. If these crops are destroyed, the Viet Congs [sic] would be required to obtain food from other sources or starve. The additional burden of importing food would decrease their effectiveness in prosecuting the war.[18]

*The cost of the phenoxy herbicides had actually been $11 per gallon. See Chapter III, p 29. General Delmore had not included the cost of the aircraft, crews, coordination of targets among various agencies, fighter cover, etc., which would have increased the per acre cost figure.

The team covered in detail which herbicides would be most effective against the various Viet Cong crops and concluded that a spray volume of three gallons per acre should be used to destroy all crops during different stages of growth. However, they did not feel that Ranch Hand should have a role in anticrop warfare:

> The C-123 with MC-1 spray system is unsuitable for crop sprays except for very large targets. It is doubtful that crop targets of sufficient size exist to warrant use of such a large spray system.[19]

The operational evaluation of the defoliation program which Secretary McNamara had requested in February finally began its journey up the chain of command on June 9, 1962. With regard to aiding border control efforts, MACV stated that defoliation was never considered in isolation but rather in support of other actions such as offensive patrols, scouts, sentry dogs, claymore mines, and surveillance points. Defoliation, however, was of no "material support" to the border control measures. The usefulness of herbicide spray as a supporting action for offensive operations was also evaluated negatively. However, MACV concluded:

> Because of the time involved to achieve any results (30–60 days) and the small improvement in visibility which was achieved, defoliation as a supporting action to offensive operations has been disappointingly ineffective.[20]

MACV's judgment of herbicides in helping protect lines of communication was mixed. In areas of high forest and tropical shrub, the MACV evaluators pronounced herbicide sprays to be of "little operational benefit," but they said that mangrove areas which principally surrounded canals were "markedly improved by defoliation." They were also impressed by the surrender of the 112 people in Viet Cong areas in the south as a result of announced defoliation plans and recommended that more attention should be paid to the possible psychological impact of the chemical spray. They gave unrestricted high marks to defoliation around military installations because of the small size of the areas involved and the accessibility of the vegetation which allowed follow-up action such as bulldozing and burning. However, the report lamented the failure of efforts to burn other sprayed areas and concluded: "It is believed that burning of large defoliated areas will always be unprofitable."

MACV recommended that two spray-equipped Ranch Hand aircraft should stay in Vietnam to continue herbicide operations in mangrove areas. Additionally, the report favored giving General Harkins the authority to use C-123s and herbicides in mangrove areas and to use the chemicals currently in Vietnam to clear areas around airfields and other fixed installations. Finally, it recommended an exhaustive testing program under the control of the Secretary of Defense in an area similar to Vietnam but where the military situation would allow for unimpeded inspection of the sprayed areas. Admiral Felt (CINCPAC) forwarded the report to the Joint Chiefs on July 17, 1962, endorsing all of its recommendations.[21]

From the beginning of its deployment to Southeast Asia, Ranch Hand had experienced much enforced idleness. This lack of activity often frustrated the Ranch Hand crews, and their Air Force superiors soon began to seek ways to use them and their aircraft. After the February meeting with Secretary McNamara, PACAF's outlook on the future of the Ranch Hand spray mission became decidedly pessimistic. The Vice Commander of PACAF observed, "I anticipate that this project will die in the near future. We should consider using the five remaining RANCH HAND aircraft as part of MULE TRAIN."[22] These comments and the events which followed showed PACAF to be unenthusiastic about the spray mission and far more interested in using the Ranch Hand C-123s in the familiar mission of hauling cargo.[23]

On March 10, 1962, TAC formally requested Air Force headquarters to re-evaluate the need for Ranch Hand aircraft and personnel in Southeast Asia with a view to returning as many as possible to the United States to support other TAC missions. This request cited the fact that two of the spray aircraft had not yet flown to South Vietnam from the Philippines. Those that had, had flown only a token number of spray missions.[24]

While this proposal from TAC was under study, MACV requested increased airlift capabilities in South Vietnam. COMUSMACV noted that the Mule Train C-123 unit was using its existing 16 aircraft to the fullest, yet Mule Train was unable to meet current airlift needs. He estimated that Mule Train would need six more C-123s just to satisfy existing requirements. Furthermore, he stated that U.S. forces in Vietnam would increase 63% by August 31 with the bulk of the growth taking place by the end of April. To fulfill his existing and anticipated airlift needs, General Harkins recommended sending an additional squadron of C-123s to South Vietnam, with six aircraft arriving by April 15 and the rest before May 15.[25]

PACAF's response to the TAC request for the return of the Ranch Hand detachment came on March 14. PACAF shared the concern of TAC over the idleness of the spray planes. However, PACAF emphasized that defoliation activities in Southeast Asia had been a test under the direct authority of the Department of Defense and that the Air Force's control of the project had been limited primarily to launching the aircraft.

PACAF also said that the airlift requirement in South Vietnam was increasing and revealed that CINCPAC had queried COMUSMACV on the possibility of retaining the Ranch Hand aircraft, but in an airlift role. Also, PACAF cautioned that the Army wanted to send Caribou transports to Vietnam and " . . . encroach upon the USAF mission." As a result, PACAF proposed keeping the Ranch Hand aircraft and crews in place for the time being. They simply did not want to lose the airlift mission to the Army by default. Afterwards, PACAF proposed to swap the Ranch Hand spray pilots quickly for troop carrier personnel who would fly the Ranch Hand aircraft as transport planes after the removal of all spray equipment. As an alternative, PACAF set forth the option of simply leaving Ranch Hand in South Vietnam until a second C-123 squadron could arrive.[26]

TAC disagreed with PACAF's proposal and, on March 20, 1962, reiterated its request to have all Ranch Hand aircraft and crews returned to their home station if they were no longer needed for spraying. TAC saw an increasing need for an aerial spray capability to support sublimited warfare, disaster control, and regular insect spray missions. The command would retain most of the existing Ranch Hand force as a permanent addition to the Special Aerial Spray Flight. To increase airlift capability in Southeast Asia, TAC preferred to send other transport units rather than convert Ranch Hand to this role.[27]

TAC's objections notwithstanding, the Ranch Hand aircraft and crews were soon put to use in the airlift role in South Vietnam. General Harkins on March 19 announced his intention to remove the spray equipment from four of the five Ranch Hand C–123s unless he received an order to the contrary.[28] On March 31, 2d ADVON reported that mechanics had begun this conversion, although one aircraft would remain configured for spraying. However, 2d ADVON noted that no requirement existed for even this one spray aircraft. Since PACAF had agreed to exchange the Ranch Hand planes for regular C–123s on a one-for-one basis, 2d ADVON wanted to trade all of the Ranch Hand aircraft and crews immediately.[29]

After shedding all spray equipment, four of the Ranch Hand aircraft and their crews began to fly cargo missions in South Vietnam. It was on one of these airlift flights near the end of April that a second Ranch Hand plane crashed. The aircraft was flying north of Hue and had received instructions to land at the last field along the coast before reaching the Demilitarized Zone (DMZ) which separated North from South Vietnam. The pilot spotted a landing strip and set his aircraft down. To his surprise, Vietnamese came running toward his C–123, and he feared, mistakenly, that he might have landed in North Vietnam. He immediately tried to take off, but the strip proved too short. Figuring that he wouldn't gain enough altitude to clear a railroad embankment, he reversed the propellers and dropped the airplane to the ground. This buckled the floor and irreparably damaged the plane, but the wings and engines were salvaged. All of the crew survived.[30]

TAC completed its plans for swapping all but one of the Ranch Hand aircraft for cargo versions of the C–123 and published OPORD 49–62 to implement this decision. This order directed four C–123s to deploy to Clark with aircrews and support personnel, arriving before the four Ranch Hand aircraft left for home. The four replacement C–123s were scheduled to leave Pope AFB, North Carolina, on April 25, 1962.[31] However, PACAF's Deputy Chief of Staff for Plans and Operations, Brig. Gen. Travis M. Hetherington, informed TAC on April 24 that, " . . . indications are that spray activities in South Vietnam are to be accelerated." General Hetherington based this upon information he had recently obtained from General Delmore, who said that he intended to recommend spray operations which

would consume the 112,000 gallons of defoliant currently remaining in South Vietnam.*

A similar recommendation from General LeMay, having just concluded a visit to South Vietnam, supported Delmore's idea. Hetherington warned TAC that if spray operations did resume, Ranch Hand might not leave Southeast Asia until July, and he advised a delay in executing OPORD 49-62.[32] One day later, PACAF recommended to CINCPAC that two spray-equipped C-123s remain in South Vietnam at least until they had disposed of all herbicides then in the country and that the other two Ranch Hand aircraft be swapped for cargo versions.[33] TAC ordered the deployment of the four cargo C-123s halted on April 25, leaving them at Luke AFB awaiting further orders.[34]

CINCPAC approved the PACAF proposal to swap only two of the Ranch Hand planes, and two C-123s departed Luke for Southeast Asia on April 28 while the other two planes returned to Pope.[35] In early May, one of the Ranch Hand C-123s returned to the United States by the Pacific route while another, under the command of Capt. Charles F. Hagerty, flew to Iran and Afghanistan to spray locusts. This aircraft returned to the United States on June 10, 1962 by way of Europe, thereby completing the first "around-the-world" flight by a C-123.[36]

On June 13, 1962 another package of proposed spray missions left Saigon on its journey up the chain of command. General Harkins indicated that officials of the South Vietnamese government were pleased with the defoliation results they had seen so far, and they had demonstrated their continuing interest by submitting requests for further missions. As he had said in his operational evaluation of the earlier missions, the American commander noted that herbicides had proven to be successful in clearing vegetation around military installations and in mangrove areas. Therefore, his proposal for renewed operational use concentrated on clearing an area surrounding the air base at Bien Hoa and improving security along roads, rivers, and canals in mangrove areas. In total, he nominated six targets totaling 15,486 acres for spraying, an effort which would consume 46,458 gallons of herbicide. The acreage, however, was later reduced around Bien Hoa from 786 to only 160 acres. Harkins said that Vietnamese helicopters would spray near Bien Hoa, but that Ranch Hand C-123s would handle the other five targets.[37]

Admiral Felt's response to the MACV proposal came within 72 hours. He readily endorsed the operation around Bien Hoa, but he sent the other targets back to Saigon for more justification. He requested information on

*Evidently around April 1962 President Kennedy approved an additional operational herbicide test along seven kilometers of road in South Vietnam. However, he rescinded this authorization on May 2, 1962 before Ranch Hand had flown any missions and stated that Thailand would be a better place for such a test. See Michael V. Forrestal, Memorandum of the President's Instructions at the Laos/Vietnam Briefing, May 2, 1962.

the military objectives to be furthered by spraying in the expanded mangrove areas of the Mekong Delta, noting that further missions for testing purposes should not be necessary. While Felt waited for this further justification, the Joint Chiefs, the Department of State, and the Department of Defense approved the operation around Bien Hoa on June 19. Although the White House learned of this decision, the Secretaries of State and Defense evidently chose not to ask for President Kennedy's specific concurrence, probably because of the limited scope of the proposal and the fact that U.S. aircraft in this instance would not do the spraying.[38]

As authorized, VNAF H-34 helicopters on July 17 and 21 sprayed the scrub growth to the north, northeast, and west of the runway at Bien Hoa with an estimated dose of three gallons of herbicide per acre. Later observations showed that the spray was highly effective against approximately 90% to 95% of the plants in the area. Of the affected plants, at least 95% lost their leaves. Herbicides improved the horizontal visibility from three to five feet to between twenty and thirty feet. The evaluators judged vertical visibility to have been improved by 80% to 90%. Bulldozers eventually cleared away the dead vegetation.[39]

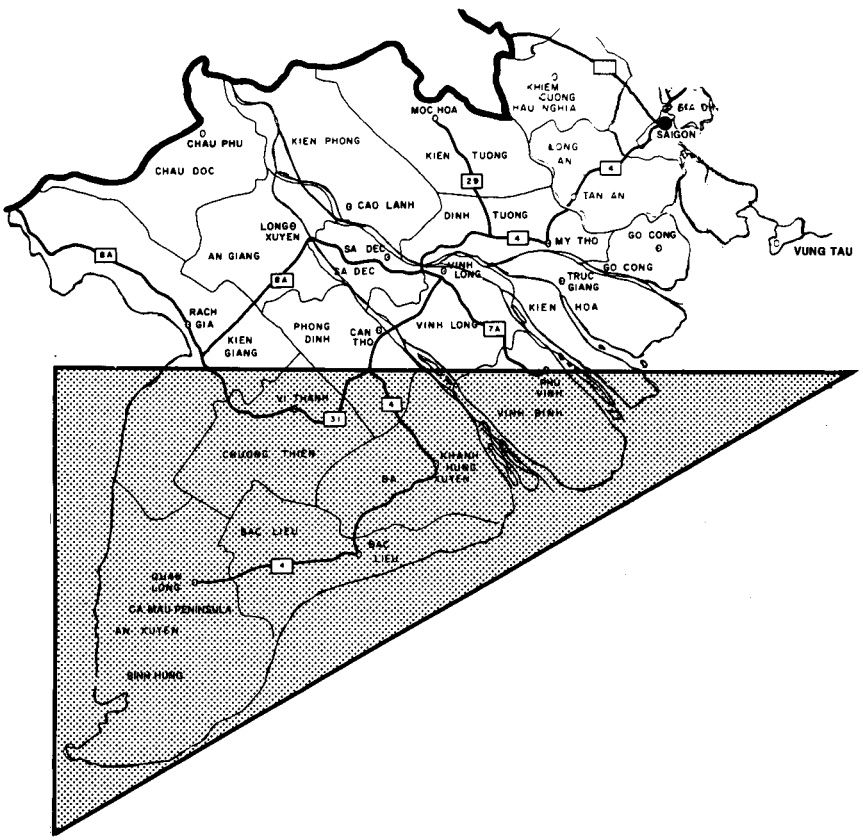
The additional justification for the Delta targets which Admiral Felt had demanded came on June 22. General Harkins said that defoliating these areas would increase visibility and thus aid ARVN units trying to detect iet Cong movements along lines of communication, improve fields of fire for ARVN forces in engagements with Viet Cong units trying to move along or across sprayed roads and canals, and deny concealed ambush sites and attack positions to the Viet Cong.[40] CINCPAC approved the request this second time and passed it forward to the JCS who added their endorsement on July 2.[41] The Secretary of Defense forwarded the request to the President on August 1, 1962, recommending approval.[42]

In accordance with the pattern he had set previously, President Kennedy cautiously approved limited operations. He authorized only those targets Secretary McNamara's memo had specifically described, and he directed that " . . . every effort be made to avoid accidental destruction of the food crops in the areas to be sprayed." He also requested a report on the results as soon as they could be evaluated.[43]

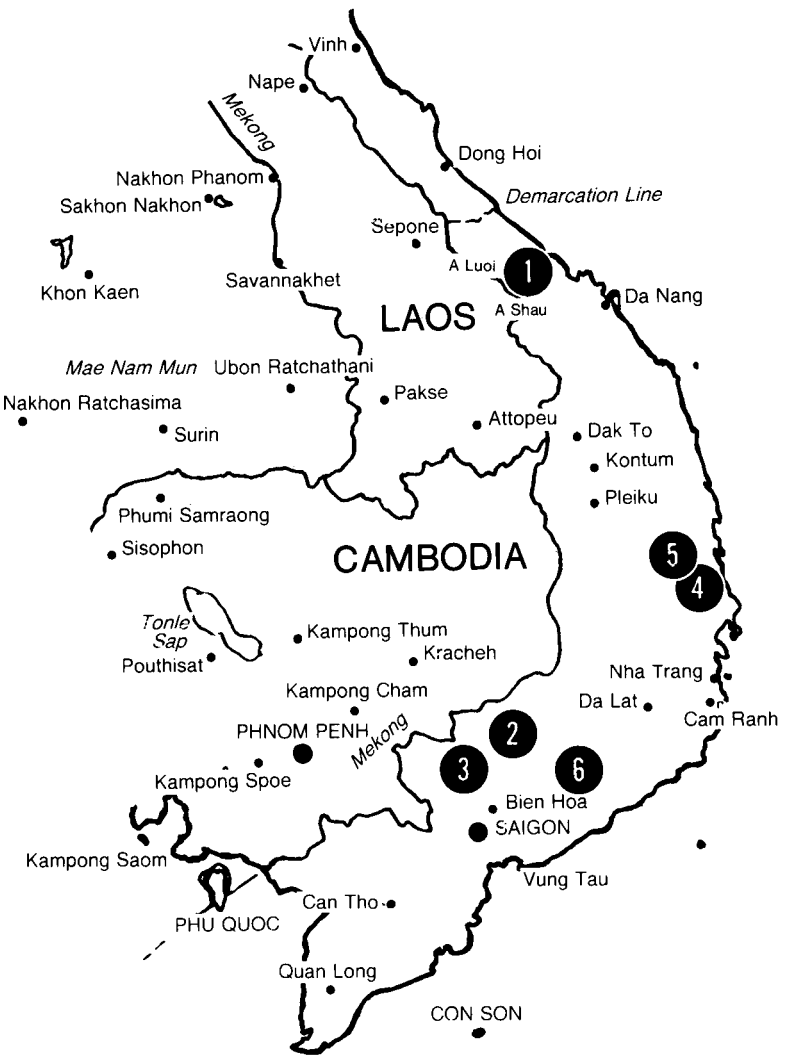
On August 14, 1962, the Joint Chiefs learned that the President had approved the operations in the Delta and that the Secretary of Defense was making a team of experts under the leadership of General Delmore immediately available to provide technical advice.[44]

At about this time, the defoliation program received a boost from an important source in the South Vietnamese government. On August 2 in a conversation with American officials, Ngo Dinh Nhu, the Political Counselor to the Presidency and, after his brother the president, the most powerful figure in South Vietnam, stated his firm belief that the defoliation program was the primary cause of a mass movement of people in the highlands which was then underway. Nhu said that the highlanders had until that time

PROPOSED SPRAY AREA
MEKONG DELTA JUNE 1962



PROPOSED SPRAY AREA
18 JULY 1962



1. ROAD CONSTRUCTION PROJECT BETWEEN A SHAU AND A LUOI
2. HIGHWAY 14
3. HIGHWAY 13
4. HIGHWAY 1
5. RAILROAD LINE
6. POWER LINE

respected the superiority Ho Chi Minh and the North Vietnamese had shown against the French at Dien Bien Phu, and therefore reasoned that the South Vietnamese had no chance against Hanoi's forces. Viet Cong propaganda, stating that the United States was using a chemical which was deadly to both plants and people, reasoned Mr. Nhu, had convinced the highlanders that the South Vietnamese now enjoyed access to a power which would enable them to defeat the North Vietnamese and their southern allies. Even though Nhu recognized that defoliants had only had a limited effectiveness so far, he urged the Americans to continue using the chemicals for their propaganda value, if for no other reason.[45]

In May the two Ranch Hand C-123s in South Vietnam had undergone modifications to replace the spray nozzles so that they would achieve a dose rate of about 1½ gallons per acre.[46] As early as July, TAC had been preparing to dispatch one additional spray-equipped C-123 to South Vietnam to arrive in early September. This plane had been modified in the United States, and Captain Hagerty had flown it on test missions over Eglin AFB, Florida, where technicians had calibrated its spray gear to deliver herbicides at the increased rate of 1½ gallons per acre. Three additional modification kits, calibrated in the United States, were ready in late August for transportation to Vietnam, where two of them would be installed in the two Ranch Hand planes already there. Although these kits would not increase the delivery rate of the two locally-modified spray planes, General Delmore wanted these modification kits installed to calibrate the planes' deposition rate. The modified C-123 departed for Southeast Asia on about September 4, arriving at Clark AFB on the twelfth. Its further deployment to South Vietnam was delayed for several days because of weather. The modification kits and technicians to install them arrived in South Vietnam at about the same time.[47]

Actual spraying by Ranch Hand C-123s began before the arrival of the third aircraft, modification kits, and technicians. During the period from September 3 to 7, the two locally modified planes flew six spray missions along the Ong Doc River in An Xuyen Province. Two additional missions were aborted because of weather. Following the operations against this first target, General Delmore called a temporary halt to the herbicide activities of Ranch Hand to allow the technicians from the United States to install the calibrated spray modification kits. They completed the installation quickly, and spray operations resumed on September 20. With the help of the third C-123, Ranch Hand, between September 3 and October 11, sprayed a total of more than 9,000 acres with 27,648 gallons of purple herbicide. These missions cleared vegetation along about 50 miles of rivers and canals on the Ca Mau Peninsula. The total acreage was somewhat less than originally projected because of efforts made in accordance with President Kennedy's admonition to avoid spraying crops and inhabited areas. Later evaluation showed that Ranch Hand's spray had killed and defoliated 90% to 95% of the treated vegetation and had improved vertical and horizontal visibilities by factors of 8 to 9 and 5 to 7, respectively.[48]

On July 18, 1962, General Harkins nominated another package of targets for spraying, and in the process of obtaining approval for them, Harkins and Ambassador Nolting gained an important delegation of authority. As originally conceived, this proposal consisted of six targets totaling 17,785 acres and requiring 53,355 gallons of herbicide. One target, eventually disapproved by Admiral Felt because of its proximity to the Laotian border, was along a planned road construction project between the two outposts of A Shau and A Luoi in the later famous A Shau Valley. General Harkins contended that removing vegetation in this target area would be essential to the security of construction workers. Four other targets consisted of vegetation along Routes 1, 13, 14, and a railroad line, respectively, all of which were continuously harassed by the Viet Cong. The sixth target was along a power line.[49]

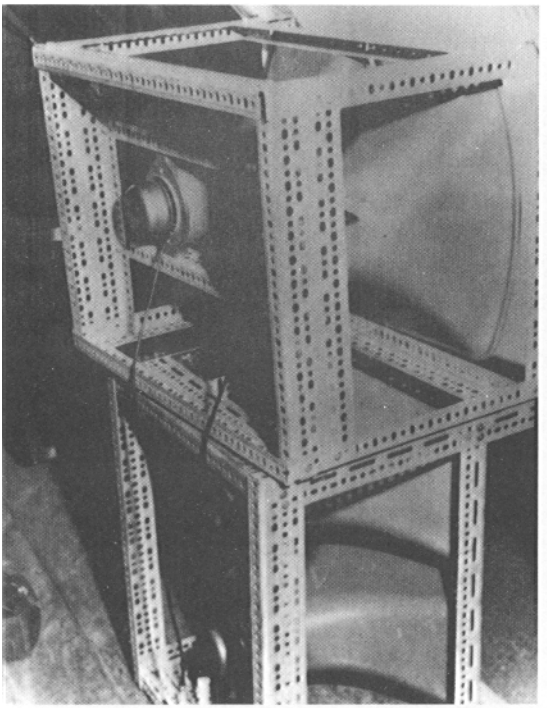
This request languished in Hawaii for about a month with no action, probably because no decision had yet arrived on the Delta targets submitted previously. After receiving clearance to spray the Delta targets, CINCPAC asked MACV if the targets proposed on July 18 were still valid. Harkins on August 30 replied in the affirmative, and he recommended that they be considered for attack after completion of the operations in the Delta.[50] Two days later Felt approved one of the targets, the one along Route 14, and forwarded this recommendation to the Joint Chiefs, noting that he had the five other targets under study.[51]

MACV on October 3 provided further, more detailed, justification for the remaining five targets in response to a request from Admiral Felt. The power line paralleling Route 20 from Da Lat, General Harkins said, was the main source of electricity for Thu Duc, and the South Vietnamese planned to tie it into the Saigon power grid in November. Although no serious incidents had occurred recently, the woods around the power line and its proximity to Zone D made it susceptible to attack. The second and third targets, Route 1 and the railroad in Phu Yen Province, had been continually harrassed by the Viet Cong. Eleven ambushes had occured in the past four months against train and road convoys between Tuy Hoa and Qui Nhon. Route 13, the fourth target area, was an artery of supply for border outposts and land development centers and had been the scene of ten ambushes, one of which killed two American advisors. Harkins considered the fifth target, the road from A Shau to A Luoi, important in the patrolling of an infiltration route along the Laotian border. General Delmore agreed with (and very possibly drafted) General Harkin's justifications.[52]

On October 6, the Joint Chiefs endorsed the operation against Route 14 in a memorandum to Secretary McNamara. They noted that psychological warfare precautions, such as avoiding inhabited and cultivated areas, dropping leaflets, and broadcasting loudspeaker warnings, which were currently part of the operation in the Delta, would also be used in the spray flights against the proposed target along Route 14.[53] Before Secretary McNamara reacted to this memorandum, however, the Joint Chiefs received Admiral

Top: leaflets were also dropped from aircraft, such as the C–47, during spray flights; bottom: airmen place surrender leaflets in a C–47 distribution chute.

P. 65 top left: loudspeaker aboard a C–47; top right: General LeMay is briefed during his tour of facilities in South Vietnam, April 1962; bottom: Gen. Maxwell D. Taylor (left) examines reconnaissance photos in the Air Operations Center at Tan Son Nhut AB, while Gen. Paul D. Harkins and Maj. Gen. Rollen H. Anthis look on.



Felt's proposal for spraying four of the five other targets he had considered. He had eliminated the target between A Shau and A Luoi because of its proximity to Laos. On October 15, the Chiefs added their endorsement to these four additional targets and asked Secretary McNamara to approve them along with the one they had forwarded nine days earlier.[54]

The office of the Assistant Secretary of Defense for International Security Affairs (ISA) received these two JCS memos for study and combined them for purposes of joint consideration with a third memo, a recommendation from the Chairman of the Joint Chiefs of Staff dated September 28, 1962, which advocated delegating to COMUSMACV the general authority to conduct herbicide operations, not including crop destruction, in South Vietnam. Noting that President Kennedy's approval of the Delta missions requested a report on the results of these operations as soon as an evaluation could be made, ISA requested the evaluation. General Harkins supplied it on October 30. ISA combined the three JCS requests with the information provided by General Harkins into one draft memorandum to the President for Secretary McNamara's signature. The State Department concurred in the final proposal, which called for the joint supervision of defoliation operations by COMUSMACV and the American Ambassador in Saigon.[55]

Secretary McNamara signed the memorandum to the President on November 16, 1962. He began by reporting to President Kennedy the results of the defoliation operations conducted up to that time, which General Harkins had rated as 90% to 95% effective against mangrove forests, and 60% effective against tropical scrub. Then, he told the President that U.S. advisors located in the vicinity of spray operations had reported no reaction from the local population. Adverse reaction, he said, had come from Radio Hanoi, but no coverage or comments had appeared in neutral or allied sources.*

Secretary McNamara directed his primary thrust toward obtaining presidential consent for delegating the authority to approve future defoliation operations to the Ambassador and COMUSMACV. He noted that Admiral Felt and the Joint Chiefs advocated allowing General Harkins to plan and conduct future herbicide operations without having to obtain specific Washington approval for each plan. The authority Secretary McNamara proposed to delegate jointly to Ambassador Nolting and General Harkins.

> . . . would not extend to crop destruction and would be limited to field decision[s] concerning operations to clear grass, weeds, and brush around depots, airfields, and other fixed installations; to clear fields of fire to inhibit surprise attack by the Viet Cong; and, in conjunction with military field operations, to

*This is a puzzling statement considering the earlier reports of adverse public comments from Peking and the presence of reporters and photographers during some of the January missions which had resulted in coverage of the operations in the American news media. Perhaps Secretary McNamara was only referring to the most recent press reactions.

> spray defoliants in areas wherein attainment of a military objective would be significantly eased. . . .

In addition to the general grant of authority for future operations, the Secretary of Defense also asked President Kennedy to approve missions involving the five specific targets nominated by General Harkins on July 18. He noted that the Department of State endorsed his recommendations.[56]

President Kennedy accepted both proposals with minor modifications and, on November 30, 1962, a joint State-Defense message informed Ambassador Nolting and General Harkins that they had clearance to conduct herbicide operations in the five specific areas proposed in July. He also delegated authority to approve herbicides in future operations. This general authority, as in Secretary McNamara's proposal, was limited to clearing roadsides, power lines, railroads, and other lines of communication, and the areas adjacent to depots, airfields, and other field installations. The authority did not extend to operations involving crop destruction. Nor did President Kennedy include in his delegation of authority the power to approve operations of a general nature in support of field operations, as against area targets like Viet Cong base areas. The message told Saigon that any operations beyond these limits were not authorized without approval from "highest authority."[57]

During the break in operations after mid-October, two of the three Ranch Hand crews completed their four-month temporary duty tours and returned to the United States. Two crews trained by the Special Aerial Spray Flight at Langley replaced them. Ranch Hand flights, before spray operations resumed in December, consisted mainly of reconnaissance to check on the results of previous herbicide missions and training to familiarize new crew members with the terrain of South Vietnam and Ranch Hand spray techniques. The unit was ready to resume operations when approval for the December missions came.[58]

After President Kennedy had specifically approved the five individual targets, the province chief in Phuoc Long Province withdrew his consent for operations along Route 14. Then, on December 5, the South Vietnamese Forestry Service and personnel from MACV conducted an aerial reconnaissance of other target areas and concluded that, except for portions of the target along Route 1, the vegetation was dormant and would remain so until about May 1963. Because this dormancy would keep the herbicide from having a significant effect, only two segments of the target area along Route 1 turned out to be suitable for spraying in December. Ranch Hand flew a spray mission against vegetation along the east side of Highway 1 south of Tuy Hoa in Phu Yen Province on December 14. The 2d Air Division Transport Operations Officer flying in the lead plane cancelled the mission after only two seconds of herbicide spray had been released on the target because he felt that the Ranch Hand C-123s could not maneuver safely over the rough terrain.[59] The Americans told the South Vietnamese that this

target would have to be sprayed by other means. On December 18 and 24, 1962, four Ranch Hand sorties successfully sprayed four kilometers of Highway 1 south of Qui Nhon. This ended the unit's spray activities until June of the following year.[60]

MACV's first operational evaluation of herbicides, produced in June and described earlier in this chapter, was, at best, mixed and unenthusiastic. However, the command revised its position in December, possibly because of experiences in the latter part of the year which were more favorable, and possibly because of more successful lobbying by herbicide advocates in Vietnam. In a letter to Admiral Felt dated December 27, 1962, the MACV Chief of Staff, Maj. Gen. Richard G. Weede, USMC, informed CINCPAC of the changes in the evaluation and requested him to pass them on to the Secretary of Defense. This second report reviewed the first report point-by-point and made several significant departures from the earlier findings.

The December report cited technicians in vegetation control who reported that herbicides had been 60% to 80% effective against evergreen vegetation and tropical scrub, even though at spraying time the vegetation had been dormant, the herbicide volume too low, and the droplet size too small. MACV now considered those results significant, and felt that the excellent results obtained on the mangroves in September and October supported the view that spraying tropical scrub and evergreen forests at the right time of the growing cycle with the new equipment would likewise lead to results of military significance.

The report also launched into a detailed discussion of improved visibility and alternate means for measuring its impact. MACV concluded that regardless of how one measured the improvement in horizontal visibility, it would aid friendly forces in countering and discourage enemy forces in planning ambushes in sprayed areas. During January 1962, before Ranch Hand sprayed selected portions of Route 15, there were 12 Viet Cong ambushes; during the nine months following the spray operations, there were 12. Incidents throughout South Vietnam from July 1961 to March 1962 rose 400 percent. The report cautioned against placing too much significance on these figures, but it said they indicated a trend which could not be overlooked. Therefore, MACV discarded some of the negative comments in its earlier findings. Because of this report and other favorable developments, Ranch Hand ended 1962 with a much brighter future than had seemed possible a few months earlier.[61]

V. Crop Destruction Begins and Washington Further Relaxes Controls on Defoliation

Chemically destroying Viet Cong crops had been considered since planning for the use of herbicides in South Vietnam began in 1961. The South Vietnamese, already destroying what they considered to be Viet Cong crops by pulling, cutting, burning, strafing or dropping napalm, held chemical herbicides to be merely a cheaper and more efficient way of fighting the war. The Kennedy Administration, however, saw crop destruction as a very significant step beyond using herbicides for clearing jungle, a step much deeper into the invidious and risky area of chemical warfare.

The first recorded test crop destruction operation in South Vietnam occurred on August 10, 1961. On that date a VNAF helicopter sprayed trinoxol on crops near a village north of Dak To, favorably impressing both American observers and Vietnamese officials.[1] In September 1961, President Diem made his first of many requests for help in destroying Viet Cong crops.[2] In late 1961 American officials in Saigon included crop destruction in their proposals for herbicide operations, and Secretary MaNamara originally authorized the deployment of Air Force C-123 spray planes and crews to Southeast Asia because of the possibility that they might be needed immediately to spray Viet Cong crops.[3] President Kennedy's decision of November 30, 1961, which served as the basic authority for initial Ranch Hand operations, prohibited crop destruction, however, and said that it might be authorized in the future " . . . only if the most careful basis of resettlement and alternative food supply has been created."[4]

President Kennedy's decision did not stop the flow of crop destruction requests and proposals. This was partially due to the fact that the U.S. Army had directed its pre-Vietnam herbicide research and development efforts mainly toward crop destruction. This aspect of herbicide use was therefore the background of Army personnel in Vietnam providing technical support to the herbicide program. Additionally, South Vietnamese officials continued to apply pressure for the release of crop destruction chemicals. With this steady tide of support from American and Vietnamese officials, and in the face of a deepening American involvement in South Vietnam, President Kennedy would in less than a year alter his policy on crop destruction. First, however, crop destruction advocates had to overcome serious opposition from the State Department.

As Ranch Hand planes sprayed the jungle in the first large-scale defoliation tests in January and February 1962, the South Vietnamese government again requested that the crop destruction program get underway. Although crop destruction was supposed to be an all-Vietnamese program, the American Embassy in Saigon was taking a hard look at the proposed program at that time to determine whether the military advantages would outweigh the political disadvantages for the United States.[5] President Diem personally pushed his government's request for crop destruction in a meeting with General Harkins in Saigon on March 19, 1962. In response to General Harkins' query whether he could positively identify Viet Cong crops, Diem replied that he "knew" where they were. General Harkins reported the conversation to Secretary McNamara and others at the Fourth Secretary of Defense Conference in Hawaii on March 21, adding that the VNAF had five H-34 helicopters equipped for crop destruction. Ambassador Nolting recommended that authorities in Washington take another look at the crop destruction proposals, favoring operations in small areas after a check to insure that the crops were those of the Viet Cong. Secretary McNamara observed that since herbicides were available in international chemical markets, he was surprised that President Diem had not suggested purchase of chemicals with South Vietnamese funds if the United States refused to supply him. William P. Bundy, an Assistant Secretary of Defense, said that the United States would still be blamed for crop destruction, even if the South Vietnamese followed this latter course of action. Secretary McNamara agreed with Bundy, but saw no reason why the United States should not destroy these crops. He said that he would try to get Ambassador Nolting the authority he needed.[6]

President Diem's crop destruction comments to General Harkins in March illustrated a difference in approaches between the South Vietnamese and the Americans in the early years and highlighted the more fundamental split between their views of the conflict in Vietnam and counterinsurgency strategies to deal with it. In areas where the South Vietnamese wanted to destroy crops at first, there were few fields which they could positively identify as Viet Cong-owned or "pure" guerrilla crops. The Viet Cong generally collected as taxes only part of a farmer's harvest, leaving him and his family with the rest. Destroying these crops in the fields would deprive the Viet Cong of some food, but the farmers would be hurt even worse. If real shortages developed, the armed guerrilla troops would be among the last to go hungry.

Diem and his government were more willing to label whole areas dominated by the Viet Cong as "VC" in their entirety and therefore proper targets for crop destruction missions and other punitive actions. The Americans, on the other hand, in applying counterinsurgency theories, felt a need to look at individuals and separate hard-core insurgents from coerced Viet Cong sympathizers and to persuade the latter that the South Vietnamese government would protect them if they would become its supporters. In following this strategy, one could not destroy all crops throughout a large

area, even if that area were dominated by the Viet Cong. Rather, information would be needed about the individual owners of every field, their past actions, and their political loyalties. Although more discriminating, this latter approach would have been impossible to implement because of the lack of detailed information about the Vietnamese countryside. Some American officials eventually came around to support the idea of punishing large areas by destroying their crops, and most at least grudgingly agreed to work with the imperfect determination by the South Vietnamese of which crops were "VC" and which were not.

Secretary McNamara was unsuccessful in quickly getting Ambassador Nolting the clearance he needed to proceed with crop destruction operations. President Diem again urged Ambassador Nolting to obtain approval for such operations in April because he was concerned about missing another growing season.[7] Shortly thereafter, the State Department authorized American officials in South Vietnam to initiate a careful testing of crop destruction chemicals and techniques to determine whether the military advantages realized would overcome the expected adverse local and international reactions. However, the Americans in Saigon were not permitted to give any chemicals to the South Vietnamese. The assumption at this time within the State Department was that if the program developed in Saigon were later approved in Washington, the United States would give the South Vietnamese the chemicals covertly, all dissemination operations would be conducted solely by the Vietnamese, and the U.S. would publicly disassociate itself from crop destruction.[8]

In early July the planning in Saigon resulted in a specific program of crop destruction operations which Ambassador Nolting and General Harkins passed on to Admiral Felt. Felt concurred within a week and forwarded the package to Washington for final approval. Harkins and Nolting advocated a trial program to be conducted by the South Vietnamese using their own helicopters against eight target areas containing 2,500 acres of rice, corn, sweet potatoes, and manioc. The spraying would be done in conjunction with the planned Hai Yen II operation designed to pacify Phu Yen Province, an area of considerable Viet Cong strength. Harkins and Nolting noted that their staffs had used the best available intelligence to select these targets and would reconfirm them jointly with the South Vietnamese before the missions were flown. No Americans would directly participate in the operation, and their role would be limited to providing technical advice and assistance. Extensive consultations with the South Vietnamese, including a briefing with President Diem on June 25, served as the basis for this plan. The Joint Chiefs of Staff added their approval to the plan on July 28 and forwarded it to Secretary McNamara.[9]

On July 18, 1962, General Harkins informed President Diem that he and Ambassador Nolting had sent a message to Washington requesting permission to conduct the crop destruction operations discussed in their March meeting, but no reply had yet come. Harkins told Diem that he hoped that

the matter could be discussed with Secretary McNamara at an upcoming meeting in Hawaii.[10] As the General desired, the subject did come up at the Sixth Secretary of Defense Conference held five days later at CINCPAC headquarters. Harkins outlined to the conferees the plan developed in Saigon and explained that fields abandoned by Montagnards as they moved to strategic hamlets needed to be sprayed in order to keep these crops from falling into guerrilla hands. He said that the Viet Cong faced a critical problem in feeding their increasing number of infiltrators. Mr. McNamara once more asked whether the South Vietnamese could obtain the herbicides on the world market, and Mr. Bundy said that Dow Chemical was a probable source of supply. The Secretary inquired of Ambassador Nolting as to whether crop destruction would cause negative propaganda inside South Vietnam. Nolting responded that destroying crops abandoned by the Montagnards should cause no problem. He also pointed out that South Vietnamese forces were already using napalm to burn abandoned fields, and fast action on a decision to use herbicides for the same purpose was necessary because the harvest season was approaching. Mr. McNamara concluded by explaining that this issue presented a touchy political problem—the United States had just agreed to a settlement in Laos and international relations in the area were in a critical phase. The matter, he said, would have to be discussed further in Washington.[11]

On July 28, Roger Hilsman, the State Department's Director of Intelligence and Research, wrote a memorandum about crop destruction to former Governor of New York W. Averell Harriman, the Assistant Secretary of State for Far Eastern Affairs. Harriman had earlier expressed doubts about the wisdom of a food surplus country such as the United States associating itself with an operation to deny food to segments of the population of an underdeveloped country.[12] Hilsman's memo was likewise negative in tone and foreshadowed later State Department objections:

> Destroying crops will inevitably have political repercussions. Intelligence is not yet reliable enough to assure that the crops destroyed are those controlled solely by the Viet Cong. Some innocent, or at least persuadable, peasants will be hurt and the Viet Cong will make the most of this in their propaganda and recruiting. Internationally, there will undoubtedly be greater reaction to a program of crop destruction than there was to defoliation.
>
> These are serious liabilities, but under certain conditions the benefits from an effective program for destroying crops might be even weightier.
>
> Food in South Viet Nam is plentiful, and it is not likely that a program for destroying crops would be effective enough to produce starvation among the Viet Cong, but two realistic strategic goals do seem possible. First, an effective program might be able to cut down food supplies enough to prevent the Viet Cong from stockpiling, thus making it difficult for them to concentrate large forces and sustain them in combat. Second, an effective program would force the Viet Cong to spend an increasing proportion of their time on acquiring and transporting food, rather than fighting.
>
> If these results could be achieved, then the political price might be acceptable. It seems clear, however, that such results could be achieved only at a later stage in the counter-guerrilla campaign, after the Viet Cong have been isolated from the peasants and driven into well-defined areas of concentration. . . .[13]

While the State Department mulled over a final position on the issue, officials in the Department of Defense moved with greater haste. On August 4, Dr. Harold Brown, the Director of Defense Research and Engineering, while taking no position on the political or operational advisability of crop destruction, said that there was a substantial probability that the operation in Phu Yen Province would fail unless additional technical expertise entered into its planning and execution. Dr. Brown recommended that if the program were approved, General Delmore and a small staff of Army, Air Force, and Agriculture Department personnel should go to Vietnam to assist General Harkins in the technical aspects of the operation. Dr. Brown also expressed his technical concern over the "first-of-its-kind" character of the Phu Yen spraying which would be part of a larger military operation and would take place before testing the chemicals, personnel, spray equipment, and tactics in a controlled area. He said that such a test should take place in Vietnam or Thailand if possible before the operation in Phu Yen.[14]

At the recommendation of William P. Bundy and the ISA staff, Secretary McNamara on August 8, 1962, signed a memorandum to President Kennedy which incorporated the Joint Chiefs' position in favor of crop destruction. Basically, he repeated the arguments for the Phu Yen operation originated by Saigon planners. He also noted that herbicide spraying would be closely coordinated with the Hai Yen II clear-and-hold operation then in progress, and that this would be the first time since the successful campaign of the British in Malaya that a strategic hamlet program had been combined with complementary food denial operations. McNamara promptly pointed out that there was ample precedent for destroying crops in South Vietnam—both government and Viet Cong forces had been burning fields routinely for a number of years. He noted that a helicopter could destroy an acre of crops in about five seconds, and as a result the Defense Department's position paralleled the South Vietnamese view that herbicides were merely a more efficient way of accomplishing a familiar end. The only possible negative aspect acknowledged in the memorandum was the psychological and propaganda fallout from crop spraying, and Secretary McNamara cited Ambassador Nolting's estimate that such reaction would be relatively negligible.[15]

Meanwhile, the State Department was pressured for its official position. On August 8, 1962, Ambassador Nolting again emphasized in a message to Washington that time was becoming a crucial factor. He warned that if the operations did not begin in the next few weeks, many of the crops would be too mature to be seriously affected. In this event, he said, the crop destruction operations might bring propaganda disadvantages with no offsetting military or psychological gains.[16] Admiral Felt dispatched an additional plea on August 21.[17] On the same date, Ambassador Nolting informed the State Department that South Vietnamese Secretary of State Thuan had formally requested 5,000 gallons of chemicals for crop destruction, and Nolting said that it was becoming increasingly urgent to receive a decision on this proposed "trial run."[18]

The State Department decision, which came on August 23, 1962, dealt a temporary setback to crop destruction advocates. In a letter to President Kennedy, Secretary Rusk stated that it was his department's position that, on balance, the disadvantages of embarking on a crop destruction program at that time outweighed the advantages. In general, his letter repeated the points Roger Hilsman had made in his memo of July 28. It might at some later stage in the counter-guerrilla struggle be proper to destroy crops, but to do so now, Rusk maintained, would be at best premature. A key drawback he cited was:

> The way to win a guerrilla war, basically, is to win the people. Crop destruction runs counter to this basic rule. The problem of identifying fields on which the Viet Cong depend is hardly susceptible to solution so long as the Viet Cong and the people are co-mingled. The Government will gain the enmity of people whose crops are destroyed and whose wives and children will either have to stay in place and suffer hunger or become homeless refugees living on the uncertain bounty of a not-too-efficient government.[19]

The day after Rusk signed his letter to the President, Roger Hilsman produced a checklist of points about crop destruction to be considered in future discussions, indicating that he, at least, didn't feel that the issue would be allowed to die. First among these points was the backdrop of the United States' use of atomic bombs against Japan and the false charges of germ warfare in Korea which would add to the difficulty of dealing with the political backlash from the use of unconventional weapons and tactics, such as crop destruction in Asia. He also noted that the Administration would be establishing a precedent by destroying crops in Vietnam which might work to our strategic disadvantage in some future conflict where an opponent would use this weapon against us or our allies. Hilsman reiterated his earlier point that advantages of crop destruction might outweigh all of its disadvantages, but only in a later stage of the war against the Viet Cong. One of his discussion points foreshadowed some of the difficulties America would later face in Vietnam:

> The Chinese Communists won against a technologically superior enemy as did the Viet-Minh when fighting the French. In both instances the Communists turned the technological superiority of the enemy to their own advantage by convincing the populace on the ground that the enemy represented "foreign imperialist barbarism."[20]

The issue wound up back in the laps of the Joint Chiefs on August 27. Deputy Secretary of Defense Gilpatric, following a telephone conversation between Rusk and McNamara, told the Chiefs that the State and Defense positions on crop destruction differed on two issues of fact:

> 1) Will the rice land targeted for the operation primarily benefit the Viet Cong or will it still help support the Montagnards in the area?
>
> 2) Assuming that the Viet Cong would be hurt by the program, would this particular denial of food supplies seriously set back their planned operations?

Gilpatric also noted that due to the delay in resolving the issue, there was a question whether it was already too late for operations against the current year's rice harvest. He asked the Chiefs to work on resolving these factual issues before President Kennedy had to decide between the conflicting State and Defense recommendations.[21] Gilpatric also requested State Department officials to query Ambassador Nolting on these issues if they agreed that a clarification of the facts was necessary before asking for White House action.[22]

In a message to Saigon on August 27, State sought amplification of the issues raised by Gilpatric. A coordinated reply from General Harkins and Ambassador Nolting came back on September 1. It acknowledged that the time for spraying the crop targets in Phu Yen Province had passed. However, despite State Department opposition, Harkins and Nolting proposed that an alternate target be chosen for spraying concurrently with some other coordinated politico-military operation. They also noted that the South Vietnamese had requested chemicals for crop destruction by troops on the ground in areas where their soldiers were already accomplishing the same end by uprooting and hand-cutting plants.

In response to the first of Gilpatric's two "questions of fact," Harkins and Nolting said that the crops proposed for destruction in Phu Yen were controlled by the Viet Cong who could be expected to benefit from them. However, they also said that the local population would suffer from the destruction of the crops, because the insurgents rarely confiscated all the food from any one plot. They hedged an answer to the second question by saying that since they did not know in detail what operations the Viet Cong had planned, it would not be possible to determine in advance precisely what effect the loss of crops would have on these plans. Also, their reply conceded that since the proposed Phu Yen operation would have been a test of South Vietnamese capabilities to spray crops on only 2,500 acres, even a successful operation would not have significantly affected the Viet Cong food supply in the whole province. In closing, the Ambassador and COMUSMACV again asked for "timely decisions" on the issue of crop destruction to avoid damaging relations between the U.S. and South Vietnam. They pointed out that joint planning for crop destruction had been going on for a year and that crop-killing herbicides had been in Vietnam during that time.[23]

Receiving the message from Ambassador Nolting, Governor Harriman summarized the response from Saigon in a letter to Secretary Gilpatric. He then attacked one of the key assumptions underlying the Defense Department's position favoring the Phu Yen areas, that is, that the Montagnards had abandoned the land near the targets. Harriman noted that the Embassy in Saigon had reported that very few refugees had come out of the mountains of Phu Yen Province, that most of those who had sought assistance from the government were ethnic Vietnamese, and that few refugees who

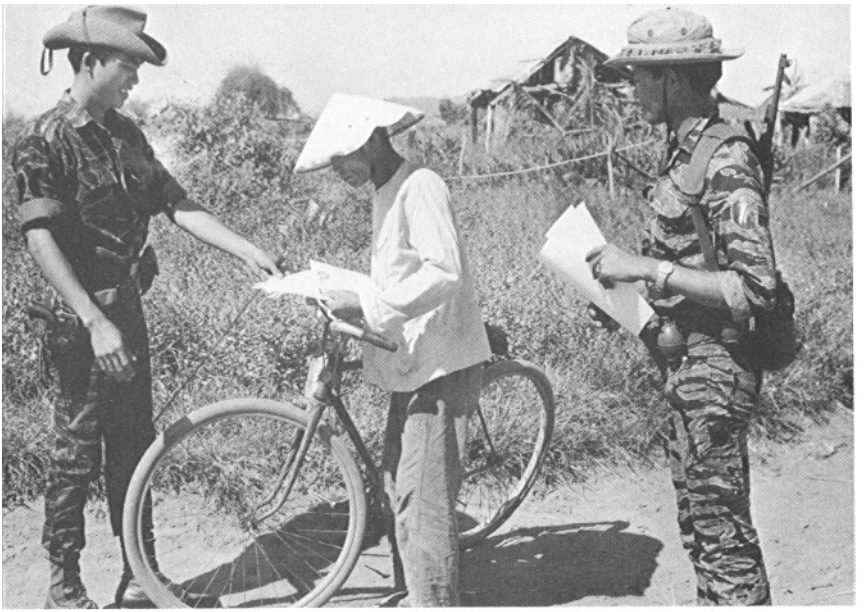
had come out were from the proposed target area. Speaking for the State Department, Harriman said:

> It is our view that it would be inappropriate to approve Ambassador Nolting's proposals, at least at this stage when the Viet Cong and the general populace are closely intermingled. We propose to prepare and seek DOD concurrence for a reply in that sense.[24]

The pressure, from Saigon on Washington, remained steady. In a lengthy report on the military situation in Vietnam, Harkins reported on September 14 that the senior advisor in II Corps felt that the Viet Cong were facing a food shortage on the high plateau. There had been numerous incidents in his area of the guerrillas trying to buy food, or actually stealing food, and he expected these incidents to increase until the next harvest in October or November. Harkins concluded that a program of food crop control and/or destruction was needed in the plateau area of II Corps. He cautioned, however, that the program would have to be coordinated by Vietnamese province officials to distinguish Viet Cong crops from friendly crops. General Harkins advocated close government control of harvesting, storage, and distribution of food in this area to deny it to the guerrillas. He only favored the chemical destruction of Viet Cong crops as a final step.[25]

At about the same time, Ambassador Nolting nominated Kontum Province in II Corps for a rescheduled crop destruction test, and he suggested that the issue be put on the agenda of the Secretary of Defense Conference scheduled for October 1, 1962. On September 15, Nolting reported that South Vietnamese Deputy Minister of Defense Thuan had given him a stack of letters from leaders of the Montagnards requesting that their crops be destroyed in some areas to keep them from falling into the hands of the Viet Cong. Nolting declared that these letters, even if government-inspired, represented impressive evidence and reinforced his conviction that at least a test operation should go forward.[26]

The event which outweighed the State Department's opposition and finally tilted the political balance in favor of initiating a crop destruction program seems to have occurred on September 25, 1962. On that date, Minister Thuan personally visited Washington and discussed the matter face-to-face with President Kennedy. He told the President that crop destruction was vital to shortening the war and was one method to aid the Montagnards in controlling the movements of the Viet Cong. In response, Kennedy asked two key questions which had been central to the issue all along: Could the South Vietnamese distinguish the Viet Cong crops from other crops, and would the usefulness of the tactic outweigh the likely negative propaganda effects? Thuan replied that the Viet Cong crops were in remote and uninhabited areas, intelligence to help distinguish the Viet Cong crops had improved, reports indicated that a food shortage existed among the guerrillas, and the Montagnards had themselves asked for the operation. Thuan urged Kennedy to at least approve chemical crop destruction using hand sprayers



Top: soldiers of a Vietnamese Armed Propaganda Team pass leaflets to villagers enlisting their support for the government; bottom: President Kennedy with Sec. McNamara and Gen. Taylor after a cabinet meeting.

in a few provinces so that the two governments could see whether the positive results would outweigh any negative effects. President Kennedy promised Thuan that he would make a decision on the matter by the end of the week.[27]

On the same day as the Kennedy–Thuan meeting (and almost surely as a direct result of this discussion), the State Department again queried Harkins and Nolting for their views, specifically questioning them on hand-spraying as an alternative to aerial spraying and asking them for any information to show how crop destruction could be done without damaging Montagnard crops.[28] Ambassador Nolting's next day reply reminded his superiors that he and General Harkins had recommended, after careful study, the aerial spraying of crops in Phu Yen Province and the hand spraying of crops in Phuoc Long Province. However, Nolting said that he and Harkins were not prepared to recommend a large-scale program until experience in these trial operations gave them a basis for evaluating the relative impact of crop destruction on the Viet Cong and the local Montagnard population. The Ambassador unequivocally ruled out any role for Ranch Hand in crop destruction and said that he had never envisaged using American aircraft in this role. If the trial program were approved, completed, and judged a success, he said, it might be appropriate to consider giving the South Vietnamese some spray-equipped aircraft.[29]

The Joint Chiefs presented their final position to the Secretary of Defense on September 29, taking into account events since their last memo. They recounted the fact that there had been repeated requests from responsible Americans up and down the chain of command for authority to conduct a trial crop-destruction operation, and they cited the urgent appeals of South Vietnamese officials, including the recent personal plea of Minister Thuan. Accordingly, the Chiefs recommended that:

> a. The current proposal for crop destruction in Phu Yen Province in conjunction with Hai Yen II be disapproved since the time has now passed to achieve maximum effective results.
>
> b. Authority be delegated to plan for and authorize GVN execution of a limited trial crop destruction operation to be conducted in South Vietnam . . .
>
> c. Herbicides in regulated amounts be released to the GVN for dissemination in ground crop destruction operations.
>
> d. Crop destruction be placed on the agenda as a topic for discussion at the Seventh Secretary of Defense Southeast Asia Conference to be held at Pearl Harbor on 8 October 1962.[30]

On October 2, 1962, President Kennedy decided to allow restricted crop destruction to proceed. The next day, Michael Forrestal of the White House staff sent the State Department a proposed draft of a message to Saigon for coordination and final dispatch. Forrestal noted in a covering letter to Harriman that it might be wise to inform Edward R. Murrow, Director, U.S. Information Agency, about the decision " . . . so that he can prepare whatever propaganda defense there is."[31]

State and Defense sent the authorizing message to Saigon on the same day. It informed General Harkins and Ambassador Nolting that the test crop destruction operations described in their messages of late September had been approved in principle and authorized them to implement their plans. However, Washington cautioned them to keep in mind four central concerns. First, spraying should be done only where the stage of crop growth promised a reasonable chance of success. Second, the targets should be chosen so as to cause the least damage possible to non-Viet Cong farmers. Third, American officials should assure themselves of the ability and willingness of the South Vietnamese government to give prompt food aid to any refugees from the target areas. And last, the message urged American officials in Saigon to consider the propaganda aspects of the operations very carefully so as to minimize their negative impact both inside and outside South Vietnam.[32] On October 20, 1962, the State Department further restricted the parameters for crop destruction by requiring that any target areas chosen be submitted to Washington for final clearance, meaning White House approval, before spraying began.[33]

As the Joint Chiefs and others had recommended, Secretary McNamara discussed crop destruction at his Hawaii conference on October 8. He directed that the first targets be sprayed as quickly as possible and that the effectiveness of these operations be rapidly evaluated.[34] On November 6, the American Embassy in Saigon requested Washington approval to spray targets in Phuoc Long Province, an alternate area chosen because the crops in Phu Yen Province were too far advanced in growth. The delay of almost a month is not explained, but the Embassy may have held back its recommendation knowing Washington was preoccupied with the Cuban Missile Crisis.[35]

Approval of the Saigon proposal came on November 8.[36] It included both air and ground crop spraying in portions of a 25-km square area of Phuoc Long Province. The scattered target fields would number about 100 and be of varying sizes up to three or four acres. Washington received assurance that the targets had been selected only after a careful analysis and examination of South Vietnamese plans.

The base for this first crop destruction operation was the airstrip at Nui Ba Ra in Phuoc Long Province. Prior to November 20, 1962, Air Force C-123s airlifted all of the needed supplies, equipment, and chemicals from Tan Son Nhut at Saigon to Nui Ba Ra. With the advice and assistance of American technicians, the South Vietnamese installed HIDAL spray equipment on five VNAF H-34 helicopters. On the night of November 20, a solution of "blue" herbicide (cacodylic acid) was prepared, and 200 gallons of this water-based mixture filled the tanks of each helicopter. The five helicopters took off from Nui Ba Ra at 0700 on the morning of November 21 in order to take advantage of early morning inversion conditions. They arrived over the target area at about 0735, but one H-34 had to return to base without spraying because of a generator malfunction. Two of the remaining

helicopters sprayed the crops from an altitude of 50 feet at an airspeed of 50 knots, but the other two sprayed from 100 feet because of tall trees nearby. They made two passes over each field to achieve a deposition rate of about two gallons per acre. One H-34 experienced an electrical problem in its pump motor and returned to Nui Ba Ra with about 100 gallons of herbicide. In total, the helicopters sprayed about 700 gallons of blue, or 300 gallons less than planned, on about 400 acres of crops. By 0815, all the H-34s were back at Nui Ba Ra where mechanics removed their spray equipment so that the helicopters could fly logistical support for the two battalions of ARVN troops securing the target areas.

That afternoon, these ARVN battalions began to move from the area of the first day's target fields, designated "R-4," to the vicinity of "R-5" and "R-6" scheduled for spraying on November 23. Between 1400 and 1700 on November 22, Vietnamese personnel reinstalled the HIDAL spray equipment on the five H-34s with the American advisors only looking on. As had been the case two days before, no U.S. personnel were allowed aboard the helicopters as they lifted off for their spray runs at 0700 on the 23d. The equipment on all five helicopters performed with only one incident this time —the pump on one HIDAL rig malfunctioned on the last pass forcing that helicopter to return with about 25 gallons of blue in its tanks. All spraying on the 23d was done from 50 feet at 50 knots. Crops sprayed that day totalled 375 acres of rice, manioc, and beans.

The psychological warfare aspects of the operation consisted of ARVN ground troops distributing leaflets in the area, although they found almost no Montagnards to take them. The troops left leaflets behind in the hope that people returning to the fields would pick them up and read them. The leaflets deliberately avoided any mention of crop destruction so as to give the Viet Cong and their international allies no additional propaganda ammunition. However, the leaflets did note that 100,000 highland dwellers had already fled the Viet Cong dominated areas and that in government-controlled areas, dwellings would always be available, food and clothes always abundant.

Both American and Vietnamese evaluators rated the results of this first crop destruction operation as generally successful. Within five hours of the first spray runs, a U.S. observer on the ground noticed that plants were wilted and discolored around the edges. Less than ten hours after spraying, another group of Americans saw that bean, peanut, potato, and manioc plants had all turned black. Two days later aerial observation by General Harkins and others found that all the sprayed crops, including rice, were brown. Photo reconnaissance missions five and seven days after the spraying showed that the brown color had deepened and that the crops were completely destroyed. A report on the operation prepared by a team headed by General Delmore estimated that the herbicide had destroyed 745,000 pounds of food, enough to feed 1,000 Viet Cong for more than a year.[37]

Shortly after this first operation, Saigon sought approval to destroy other crop targets. Ambassador Nolting notified Washington on November 26 that he had received an urgent South Vietnamese request for chemicals to carry out aerial crop destruction in Zone D in conjunction with a continuation of the military operation of which the Phuoc Long activity had been a part. General Khanh, the ARVN Deputy Chief of Staff, said that he planned for his troops to enter Zone D on November 27 about 25 km southwest of the Phuoc Long crop targets. He wanted the authority to have helicopters spray any crops his troops might find beginning on the 28th. Because Zone D was the "hardest of hard core VC areas," Saigon officials felt that a minimum psychological warfare effort would be needed. General Harkins and Ambassador Nolting strongly recommended that they be given discretionary authority to approve these operations.[38] Averell Harriman, then visiting New Delhi, seconded this recommendation,[39] and approval came from the Secretary of State on November 28. The authorizing message from Washington took issue with one aspect of the Saigon plan, however:

> Even though Zone D is considered as VC sanctuary believe it unwise assume all inhabitants are VC therefore TF/Saigon must ensure there is maximum, not minimum, psywar and rehabilitation effort.[40]

All of the hurried efforts were for naught, because by the time Washington approval came, the first areas to be sprayed were not secure enough for helicopter operations. Another set of fields in Zone D was to be sprayed on the morning of November 30, but Typhoon Lucy forced the cancellation of the operation.[41]

On November 30, Harkins and Nolting submitted a third request, this time for permission to spray some 300 acres of Viet Cong crops in Thua Thien Province. Because of the terrain and proximity to the Laotian border, they contemplated no helicopter operations, and the herbicide, agent pink, would be sprayed from the ground by hand. The Ambassador admitted that authorities in the province had almost totally ignored the psychological warfare aspect, but he assured Washington that he would not approve the operations until he was satisfied with their efforts in this regard.[42]

Washington approved this operation on November 30 subject to adequate psychological warfare and rehabilitation efforts, but the spraying in Thua Thien did not take place until February, May, and June 1963. This delay may have indicated that these latter efforts took a longer time than originally hoped.[43]

On February 3, 1963, a series of ten lengthy articles on U.S. policy in Asia by a reporter named Richard Dudman began appearing in the *St. Louis Post-Dispatch* and other newspapers, including the *Washington Star*. Several of these articles dealt with Vietnam, and they attracted the attention of some influential legislators, including Senator Mike Mansfield of

Montana who had the entire series printed in the March 4 edition of the *Congressional Record*. Senator Mansfield said that Mr. Dudman's articles were first-rate and an example of careful reporting. He commended them to the attention of the Senate.[44]

The fourth article in the series claimed that the U.S. and its South Vietnamese allies were using "dirty-war" tactics against the Viet Cong and that Operation Ranch Hand was one such tactic:

> Take, for example, Operation Ranch Hand, a system of spraying the land with poison to kill plants that provide the Communist-led guerrillas with food and shelter.
>
> Officials hope it can be effective in helping starve out and flush out the enemy Viet-cong. Details are secret, but it is known that converted U.S. Air Force planes sweep across the countryside spraying poison from nozzles along their wings to destroy rice fields around insurgent strongholds and to strip the brush from roadsides where the enemy sometimes hides in ambush.[45]

Dudman went on to say that for technical reasons the spray had not worked well, and that the important question raised by the tactic was whether the military advantages outweighed the political disadvantages and the resentment engendered by the destruction of food.*

Congressman Robert W. Kastenmeier of Wisconsin was disturbed enough by this article that he penned a letter to President Kennedy urging him to renounce the use of chemical weapons, especially herbicides, in South Vietnam. He started his letter by recounting how, at the height of World War II, President Franklin Roosevelt had declared that the United States would under no circumstances use chemical weapons unless they were first used by an enemy. Then he quoted a similar statement by President Eisenhower. Kastenmeier correctly maintained that the crop spraying which had taken place represented a change in American policy in Vietnam which had previously prohibited such operations. In his view this was far different from our policy during World War II when, in the face of fanatical resistance from entrenched Japanese troops, Adm. William Leahy told President Roosevelt that using chemicals to destroy the Japanese rice crop " . . . would violate every Christian ethic I have ever heard of and all known laws of war." Kastenmeier said that because of the confusing nature of the war in South Vietnam, we could not be sure that we were destroying only food destined for the Viet Cong. Viet Cong terror and U.S.-South Vietnamese counter-terror tactics, he said, created a horrible dilemma for the common Vietnamese citizen concerned only with saving his own life and that of his family. He questioned whether the survival of the Diem regime was worth compromising America's moral principles. In closing, Kastenmeier pleaded with President Kennedy to join other Presidents in

*Dudman was not entirely correct. When he wrote his articles, no U.S. planes or helicopters had been used to spray rice or other crops. Also, the spray was not at that time thought to be "poison" except in the limited sense of being deadly to plants.

declaring that the United States would never be the first to use chemical or biological weapons and to order a halt to the present "starvation tactics" in South Vietnam.[46]

On March 13, 1963, President Kennedy, prompted, it seems likely, by the Kastenmeier letter, had asked the Departments of State and Defense and the U.S. Information Agency for an up-to-date report on the results of defoliation and crop destruction operations in Vietnam.[47] Lawrence F. O'Brien, Special Assistant to the President, referred the Kastenmeier letter to the Department of Defense for a direct reply to the Congressman. William P. Bundy signed the letter of reply on March 16. Denying that chemical and biological weapons had been used in Vietnam, he said the moral question raised by Kastenmeier was not at issue. Bundy claimed that the definition of chemical warfare under international law required that damage be done to the physical person of the enemy, and that since the chemicals employed in Vietnam were widely used commercial weed killers which were not harmful to man, animals, or the soil, it could not be said that poisons or chemical warfare agents were in use in Vietnam. Bundy explained that the South Vietnamese had, with technical and logistics assistance from the U.S., sprayed herbicides along lines of communication and in areas around military bases. However, Bundy did not elaborate and reveal that this "assistance" had included Air Force planes and crews who had actually flown the missions with little involvement by the Vietnamese except in the selection of targets. Secretary Bundy confirmed to the Congressman that the South Vietnamese, without the participation of the U.S. except for the provision of chemicals, had sprayed Viet Cong crops, but only in a few cases, and then as an alternative to manual destruction.

Maintaining that the denial of food was a "wholly normal procedure" in wars against insurgents as well as other forms of warfare, he said that extreme precautions had been taken to insure that the South Vietnamese had only sprayed crops which were part of the Viet Cong food supply. He then closed the letter with an expression of regret that the press and communist propaganda organs had distorted the facts relating to the matter and stated that the American Embassy in Saigon had been advised to provide newsmen with complete details of the herbicide operations.[48]

On March 20, 1963, at Washington's suggestion, the South Vietnamese held a full-scale press conference. Eighty journalists, the largest turnout to that time, heard a South Vietnamese government spokesman explain the need for herbicide operations, their nature, and their purpose. Vietnamese officials had prepared the text of the statement, with some U.S. assistance. And although U.S. officials stayed in the background during the briefing, they had been ready to step in if the South Vietnamese had experienced any difficulty.[49]

Two days after this press briefing, CINCPAC dispatched to the Joint Chiefs a report which evaluated the psychological warfare aspects of the defoliation and crop destruction operations conducted in Vietnam through

January of 1963. Its conclusion was favorable to the use of these chemicals and asserted that the benefits of herbicides far outweighed any psychological costs caused by communist propaganda. To the contrary, the study claimed that inaccurate propaganda about the deadliness of the spray may have had a boomerang effect on the Viet Cong causing in at least one instance the surrender of a group of guerrillas and their sympathizers out of fear. Other than this possible reverse impact on the Viet Cong, Admiral Felt said that communist propaganda had had little impact on either the Vietnamese population as a whole or the outside world. To further reinforce this positive view, he concluded that the recent increases in propaganda statements denouncing the use of herbicides were to be expected and constituted the best possible evidence that defoliation and crop destruction were having a negative impact on the Viet Cong.[50]

The State Department, on March 15, 1963, had asked Ambassador Nolting and General Harkins to provide their best information about defoliation and crop destruction and to include statistics, plans for future operations, and methods for increasing the military effects of the program while decreasing the adverse political reaction. The White House query of March 13 had prompted this message to Saigon, and State had told the American officials that this request for information came from the "highest authority."[51] The reply from Saigon came on March 20. Ambassador Nolting reported that it was extremely difficult to obtain precise statistical results of herbicide missions, and, that to some extent, his conclusions has been based on the absence of adverse evidence rather than the presence of positive evidence. He expected the South Vietnamese to soon submit extensive plans for both crop destruction and defoliation missions, and he felt that it was important to decide rapidly on the future basis for herbicide operations so that they could be informed and could develop their plans accordingly. Regarding a future course, he cabled:

> . . . General Harkins and I recommend that chemical defoliation and crop destruction be continued (latter as integral part of more general GVN food denial program) but on new footing: Instead of considering chemical defoliation and crop destruction as separate program under which appropriate targets can be selected, herbicides should be considered as an effective tool to be employed in specific situations and areas . . . In both defoliation and crop destruction, however, emphasis should mean greater dependence on views and recommendations local commanders and advisors rather than on those of GVN/JGS in Saigon. . . .
>
> Procedurally, General Harkins and I recommend that we be given authority to approve crop destruction now, as well as authority approve other defoliation targets in addition to lines of communication and related areas. We would continue report operations fully to Washington with our evaluations as info becomes available. Regarding selection targets, we would envisage continuing same careful selection process used to date, judging selection on basis existing criteria.[52]

Rather than submit a separate report, General Harkins endorsed Ambassador Nolting's views, adding a plea that the additional authority they had requested be granted as soon as possible so that they could take advantage of the approaching growing season.[53] Admiral Felt added his endorsement to this request one week later.[54]

On April 4, 1963, while the State and Defense Department bureaucracies were formulating their formal positions, President Kennedy met with Mr. R. G. K. Thompson, head of the British Advisory Mission to Vietnam, who gave him a decidedly negative report on the use of herbicides in Vietnam. Thompson doubted the worth of defoliation since even when the trees were dead, enough cover was provided by branches and twigs to furnish the Viet Cong with hiding places. He also spoke of Asians' automatic aversion to the use of unknown chemicals. Crop destruction, he believed, should only be done where it was certain that there were no sources of supply for the Viet Cong other than the crops being destroyed. After this discussion President Kennedy reiterated his request for the review of the defoliation and crop destruction programs, a review which was then underway.[55]

The Joint Chiefs of Staff provided their view on the value of herbicides and recommended future courses of action to the Secretary of Defense on April 17, 1963.[56] William P. Bundy adopted their view as the Defense Department's position in a letter to Averell Harriman on April 19.[57] Bundy described the herbicide targets to date, saying 87 miles of roads, canals, and areas bordering military installations had been sprayed along with 750 acres of crops in Phuoc Long Province and 29 acres in Thua Thien Province. Labeling herbicides a "weapons system," he said that, like other weapons, a precise statistical determination of their effectiveness would be difficult. However, he noted that reports from the field had been positive and that the Joint Chiefs considered defoliation one tool among many in the counterinsurgency kit. Future operations being planned included at least 12,000 acres of defoliation targets and 4,000 acres of crop destruction targets. Bundy repeated Admiral Felt's conclusion that the propaganda costs of herbicide operations had been minimal and that communist propaganda barrages should be viewed as indicators of the degree of success the program was achieving. In closing, he recommended, on behalf of the Defense Department, that defoliation and crop destruction operations be continued. He advocated asking the President to authorize Ambassador Nolting and General Harkins to approve crop destruction and defoliation targets on their own in accordance with the existing criteria with reports and evaluations continuing to flow into Washington.

While awaiting the President's decision, the Joint Chiefs felt the increased sensitivity of the herbicide issue and suspended all herbicide operations on May 2, 1963 pending receipt of new instructions expected within four or five days.[58] The need for this suspension evaporated on May 7,

when the State Department issued new guidelines resulting from a review of the herbicide program at the "highest levels":

> Defoliation: 1. Authority to initiate defoliation operations is delegated to Ambassador and COMUSMACV. 2. Guidelines: Defoliation operations should be few in number, undertaken only in following circumstances: a) where terrain and vegetation peculiarly favor use of herbicides; b) in areas remote from population; and c) when hand cutting and burning are impracticable. A few high priority projects can be undertaken in populated areas where military advantage very clear and hand cutting and burning not feasible.
>
> Crop Destruction: 1. All crop destruction operations must be approved in advance by Assistant Secretary FE and DOD. 2. Guidelines re Crop Destruction: a) Crop destruction must be confined to remote areas known to be occupied by VC. It should not be carried on in areas where VC are intermingled with native inhabitants and latter cannot escape. Also should be limited to areas where VC either do not have nearby alternative sources food or areas in which there is overall food deficit e.g. High Plateau and Zone D.
>
> General Comments (applicable to both defoliation and crop destruction):
>
> a. All herbicide operations to be undertaken only after it is clear both Psy-War preparations and compensation and relief machinery are adequate. Would appear GVN should increase compensation efforts.
>
> b. Suggest further increase reliance on hand operations where feasible which less awesome than spraying by air.
>
> c. Continue efforts counteract international effect Commie propaganda through demonstrations, visits by newsmen, etc.
>
> d. Request by first week July a full report and evaluation all 1963 herbicide operations to serve as basis decision whether continue defoliation and crop destruction.

Secretary Rusk's signature appeared at the bottom of the message.[59]

Thus, negative publicity and political criticism led to a reexamination of the herbicide program. This resulted not in a contraction of the effort, but in the delegation of more authority to approve operations to lower levels in the chain of command. Still, Washington maintained control over crop destruction, and the required report in two months would insure that high levels of the government would again have an opportunity to evaluate the herbicide program and rule on its continuation.

VI. Ranch Hand's Mission Expands and Becomes Routine

Ranch Hand's three spray planes had flown their last herbicide mission in December 1962, prior to the issuance of the May 7, 1963, guidelines. The South Vietnamese dry season and the confusion over high-level policy limited Ranch Hand's activities during the intervening five months to assignments not related to the spray work for which the unit had come to Vietnam. In this interim period, they flew transport, navigational aid testing, and radar target missions. The transport flights were in support of the Mule Train logistics mission and included the delivery of cargo, munitions, and personnel. Ranch Hand aircraft and crews also participated in some combat parachute drops. Two of the unit's C-123s had special radio gear installed to test the British-designed Tactical Air Positioning System (TAPS), and they flew a total of 65 sorties in support of the TAPS testing program. As part of an effort to develop a ground controlled intercept (GCI) capability in South Vietnam, Ranch Hand crews and aircraft flew simulated hostile aerial penetration flights during this period. They generally flew at low level and provided excellent GCI practice to both ground radar operators and U.S. and Vietnamese pilots.[1]

Ranch Hand finally got back into the spray business in June 1963, when the unit began applying herbicides along 46 kilometers of canals on the Ca Mau peninsula. Eight sorties, dispensing 7,200 gallons of chemicals, were flown in this region of IV Corps between June 6 and 9. Only light enemy ground fire harassed the crews over these targets, with no damage to Ranch Hand's C-123s. The unit flew spray missions again in July, this time along a power line extending from Da Lat to Bien Hoa. From July 3 through 27, Ranch Hand sprayed 10,722 gallons of herbicide during 19 sorties along 58 kilometers of the transmission line right-of-way. Because the line traversed mountainous terrain, Ranch Hand crews first surveyed its entire length to determine which portions were suitable for spraying by their C-123s, and which would have to be covered by slower, more maneuverable VNAF helicopters. Ranch Hand sprayed this series of targets without incident, except for delays because of adverse weather conditions.[2]

In August 1963, Thailand requested Ranch Hand's aerial spray services through the U.S. State Department. This neighboring Southeast Asian country was suffering widespread and serious crop damage from locusts. One Ranch Hand aircraft and crew flew to Thailand on August 30 to coordinate the requested insect eradication project. On the following day, they flew the first of 17 insecticide missions which continued until September 16.

A second Ranch Hand aircraft arrived to help on September 8. Thai officials considered Ranch Hand's work, which demonstrated the unit's diversified aerial spray capabilities, extremely successful.[3]

The May 7 message from the Secretary of State required that a full report and evaluation of all 1963 herbicide operations to date be sent to Washington by the first week in July. Because Ranch Hand had not resumed spraying until June and because the crop destruction spraying in 1963 had been very limited, American officials asked for and received authorization to move the due date back to October 1.[4]

On September 4, 1963, MACV appointed a team to conduct this evaluation and prepare a report. U.S. Army Lt. Col. Peter G. Olenchuk headed the team. He was assisted by Army Lt. Col. Oran K. Henderson, Air Force Maj. Wayne E. Davis, and Mr. Robert T. Burke of the Political Section of the American Embassy in Saigon. This team of Americans had the mission of evaluating the technical adequacy, military worth, psychological and civil affairs aspects, policy, and procedures of herbicide operations which had taken place in South Vietnam since September 1962. They selected this broader base period covering ten defoliation and two crop destruction targets to provide a sufficient amount of data for evaluation.

Using C-123 aircraft, team members and their assistants flew over all sections of the defoliated targets under study at 75 to 150 feet in order to assess vertical and horizontal visibility in the defoliated strips in comparison with contiguous unsprayed areas. At least five observers rated each target on standardized forms, and they tested inter-observer reliability by overflying non-defoliated areas, obtaining close correlation of observer visibility estimates. The team estimated the average vertical and horizontal visiblity over non-sprayed areas adjoining the nine defoliated targets as 40% and 30%, respectively. However, over the defoliated areas, average vertical visibility had improved to 80%, and horizontal visibility had increased to 75%. They found no major technical deficiencies in the Ranch Hand spray equipment or aircraft, but they did note that the effectiveness of the spray was sometimes degraded by the inherent inability of the C-123s to follow precisely the sharply twisting and turning paths of roads, rivers, canals, and the power line. Although they did not personally inspect the crop destruction targets, they noted that conclusive reports indicated that except perhaps for some root crops, the sprayed fields had been 100% destroyed.

The Olenchuk Report rated the military worth of defoliation and crop destruction as high. The team found that improved visibility had eased the problem of providing security in defoliated areas, had made aerial surveillance much more effective, and had enabled ground security forces to be reduced.* Defoliation had also created an increased field of fire for

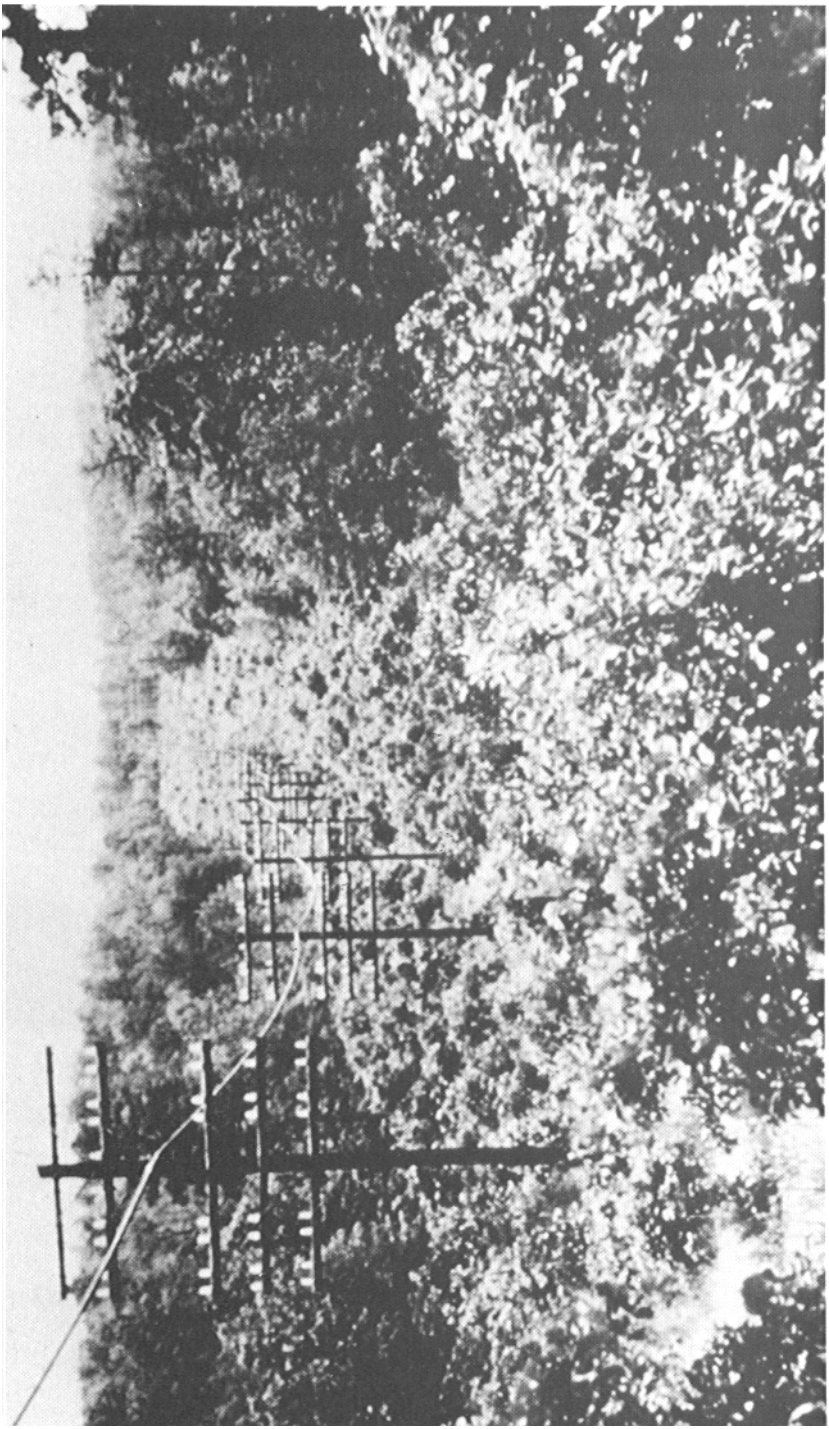
*This latter result would have been a questionable benefit in the eyes of some critics of U.S.-GVN counterinsurgency strategy because it reduced the government presence on the ground in contested areas and increased Saigon's reliance on remote technological means of control.

troops on the ground, a benefit which, however, accrued to both South Vietnamese troops and the Viet Cong. In view of the reluctance of the Viet Cong to operate in defoliated areas, the evaluation team concluded that the South Vietnamese derived the most benefit from this effect. Province officials in defoliated areas reported to the team that the Viet Cong had initiated fewer incidents since the sprying had taken place, and the team's independent analysis of tabulated data confirmed this finding. They asserted that, in theory, a crop destruction could have a serious effect on the Viet Cong, but they made no claims of extensive impact for the two operations which had been conducted, probably because the amount of targeted crops was so small.

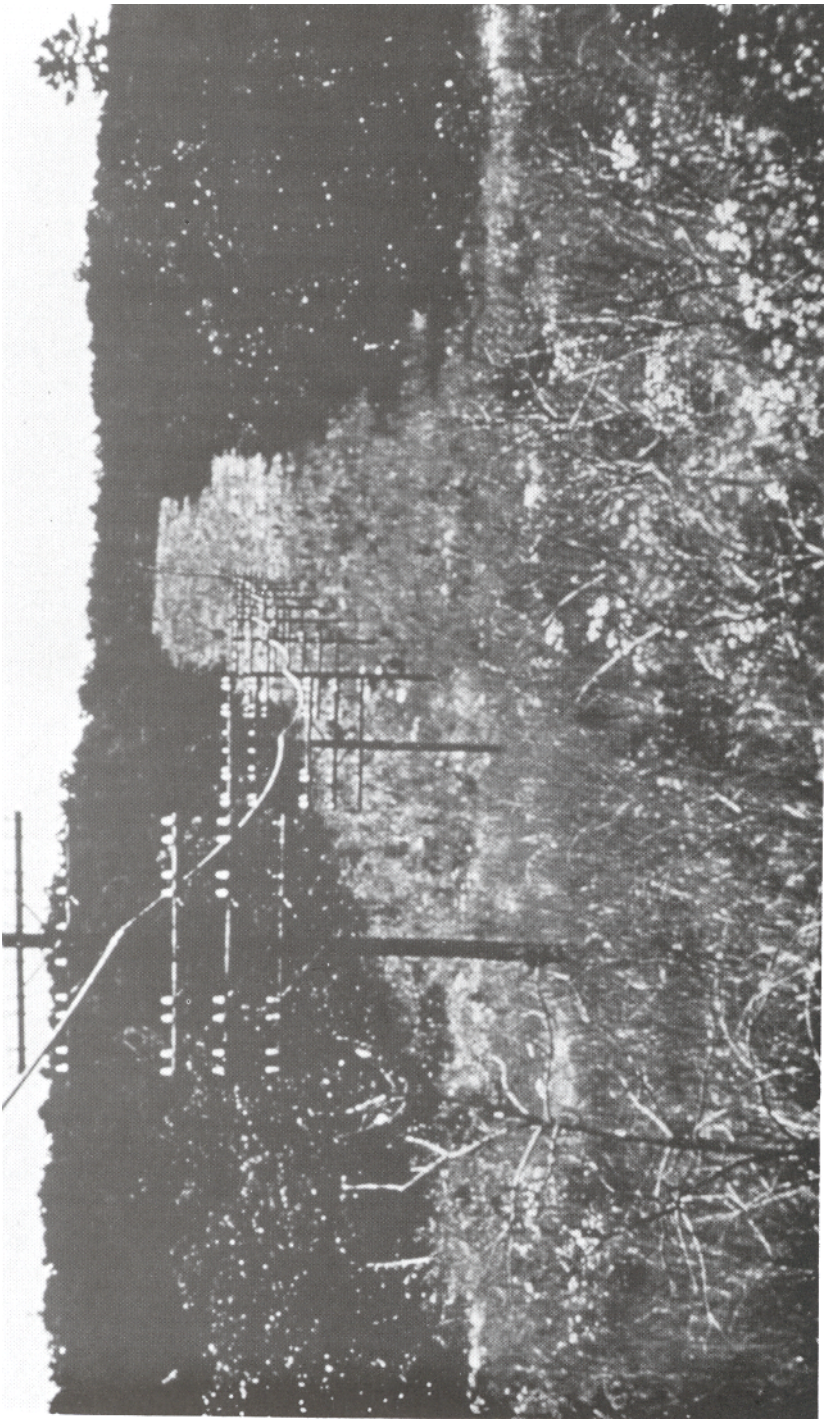
In sum, the team found that the technical and military effectiveness of defoliation and crop destruction was high. They cited the earlier CINCPAC evaluation of the psychological and propaganda impact of herbicides which concluded that costs in these areas were low. The team's main negative findings concerned the South Vietnamese government's handling of reimbursement for damages and the policy restrictions which complicated the approval process for herbicide usage. Olenchuk and his team found that although there were a number of confirmed instances where crops of nonhostile civilians had received accidental damage during defoliation operations, no monetary reimbursement had yet been made to the people for the losses. They cited cases in five different provinces where delays because of the lack of funds, problems in assessing damages, and the general inefficiency of the South Vietnamese bureaucracy had held up the payment of claims for months, and concluded that this situation presented a difficult civil affairs problem. On another civil affairs problem, the team said that the South Vietnamese had, as the Americans required, planned and conducted psychological operations consisting of leaflet drops, loudspeaker broadcasts, and supplementary ground teams in all cases except where aircraft would have been jeopardized. However, the general lack of relevance between these operations and the realities of the situation in hard-core Viet Cong areas had caused justifiable South Vietnamese disenchantment with psychological operations in conjunction with herbicide missions.

In the area of approval of herbicide requests, the Olenchuk team found that with few exceptions the reaction time from field requests to execution of the missions was extremely long, typically three months to a year. The highly centralized nature of the approval procedures for herbicide usage flowed from U.S. policy restrictions which dictated maximum control. The tactical necessity for spraying plants at the proper stage of growth in order to achieve maximum effects required a shorter response time and, in the team's view, more decentralized authority.

The Olenchuk Report concluded with eleven major recommendations, only the first two of which Ambassador Henry Cabot Lodge (successor to Ambassador Nolting) specifically endorsed when he signed the report. General Harkins, by contrast, penned no limitations over his signature



Brush-infested area in a right of way (United States).



Same area—one year after treatment with 2,4-D and 2,4,5-T.

on the report's cover sheet. The first recommendation was for the continuation of herbicide operations in South Vietnam under the existing guidelines governing where and under what circumstances these chemicals could be used. The second recommendation called for the delegation of approval authority over crop destruction to the U.S. Ambassador and COMUSMACV, a departure from the restrictions imposed by Secretary Rusk's message of May 7. Recommendation number three was to empower ARVN division commanders to authorize all hand spray herbicide operations subject to the concurrence of their U.S. division advisor. The other eight recommendations were technical in nature and concerned such things as improving the system for paying for herbicide damages, permitting follow-up spraying after the initial execution of defoliation missions, making meteorological support more effective, and conducting research to produce improved herbicides and delivery systems. The primary importance of the Olenchuk Report, however, was that it pronounced defoliation and crop destruction both technically and militarily effective and obtained the endorsement of Ambassador Lodge and General Harkins for the continuation of the program.[5]

Following a two month delay in August and September of 1963, Ranch Hand resumed spray operations. After that time, high-level disputes over policy caused no more lengthy gaps between spray missions. Seasonal lulls, however, during the dry months in the early part of the year did continue. Ranch Hand flew 82 sorties between October 14, 1963 and January 13, 1964, dispensing 71,360 gallons of herbicide on six separate target areas. Three of these involved highways, one was a railroad and one was a canal on the Ca Mau Peninsula. The sixth target included part of the Viet Cong base area in Zone D. Defoliation in Zone D increased ground-to-air visibility and enabled a more accurate evaluation of the effectiveness of fighter strikes.[6]

In December 1963, Ranch Hand tested the feasibility of conducting defoliation missions at night. Because the heat of the sun created thermal updrafts which dispersed the spray, the only time spraying could be done at maximum effectiveness during daylight was just before sunset and just after sunrise. Crosswinds were also greater during the daylight hours. Being able to fly herbicide missions at night would have given Ranch Hand much more flexibility in scheduling missions and would have increased the element of surprise over Viet Cong gunners and reduced the effectiveness of their ground fire which was, by this time, becoming worrisome. Ranch Hand flew its first night test mission on December 8 and utilized flares dropped from a flare ship above and to the right of the spray plane to light the target. This mission was judged highly successful, as was a second, later, test—conducted by moonlight only. On the second flight, however, the spray planes received considerable small arms fire, leading to the conclusion that night tactics should be used only sparingly and never twice in succession over the same target. The targets suitable for night spraying were those which were

straight, easily visible, and surrounded by flat terrain. Close coordination necessarily had to be maintained between the spray planes and the flare ships. Flickering shadows cast by the flares, however, posed difficulties for the pilots trying to judge precise altitudes. Because of these problems, night spraying never became very important.[7]

During January 1964 the majority of Ranch Hand flights surveyed the results of previous spray runs and evaluated future target areas. Most of the remainder of the missions were logistics flights in support of Mule Train and test missions for a navigational program. A target on the Ca Mau peninsula received a handful of spray sorties in January. In February, Ranch Hand returned to the peninsula and sprayed a wide canal located on its southern tip which connected directly with the Gulf of Thailand. This target required 16 sorties and 14,050 gallons of defoliant. Because of the target's size and its accessibility to the sea, the Vietnamese Navy provided ground security. Small armed boats, normally used in coastal patrols, occupied the target area during the spray runs and were successful in suppressing ground fire. None of the spray aircraft sustained any serious damage.[8]

Ranch Hand targets during March and April 1964 were also on the Ca Mau peninsula, but they were too far inland to be reached and secured by the Vietnamese Navy. Vietnamese ground forces were totally unable to provide security in the area which was, by this time, dominated by the Viet Cong. As a result, ground fire from the target areas created extremely hazardous conditions during the spray runs. Although Viet Cong ground forces normally had weapons no larger than .30 caliber, Ranch Hand aircraft on the average sustained four hits per mission during operations over these targets. The spray planes occasionally had hydraulic or electrical systems disabled by ground fire, and twice emergency landings were necessary because landing gears had been shot out.[9]

A mission flown by Ranch Hand along the Bay Hap river in the Mekong Delta on April 22, 1964, caused a great deal of controversy because of allegations of crop damage near the model strategic hamlet of Cha La. In other ways, however, it was typical of the missions Ranch Hand flew during this time period. Preliminary discussions between American and South Vietnamese officials to arrange for aerial defoliation of rivers and canals controlled by the Viet Cong in An Xuyen Province, took place in December 1963. These officials rated a 38 kilometer segment along the Bay Hap river as the first priority for spraying because the Viet Cong continually ambushed or harassed convoys traveling to the outposts at Cha La and Thuan Hung. The South Vietnamese High Command sent a formal defoliation request to MACV in late February 1964, and on March 4, 1964, MACV representatives met in An Xuyen Provincial Headquarters with Vietnamese officials and their U.S. advisors to further evaluate the need for defoliation in the area and, because of a recent coup,* to revalidate the provincial certification.

*The overthrow of the Diem regime in November 1963 ushered in a period of turbulent political upheavals in South Vietnam which was to last for several years.

In accordance with standard procedure, the Vietnamese officials at this meeting certified the authorized limits of the target area around Cha La by their signatures and official seals on special 1:4000 scale aerial photographs. This assured accurate delineation and positive identification of the areas they wanted sprayed and the areas which should be skipped by the herbicide planes so as to avoid damaging the crops of friendly civilians. MACV approved the defoliation request on April 16 after a final review by MACV and American Embassy personnel.[10]

Ranch Hand first flew against this complex of targets on April 22, 1964. In May, Jim G. Lucas, a Scripps-Howard staff writer, submitted the following article:

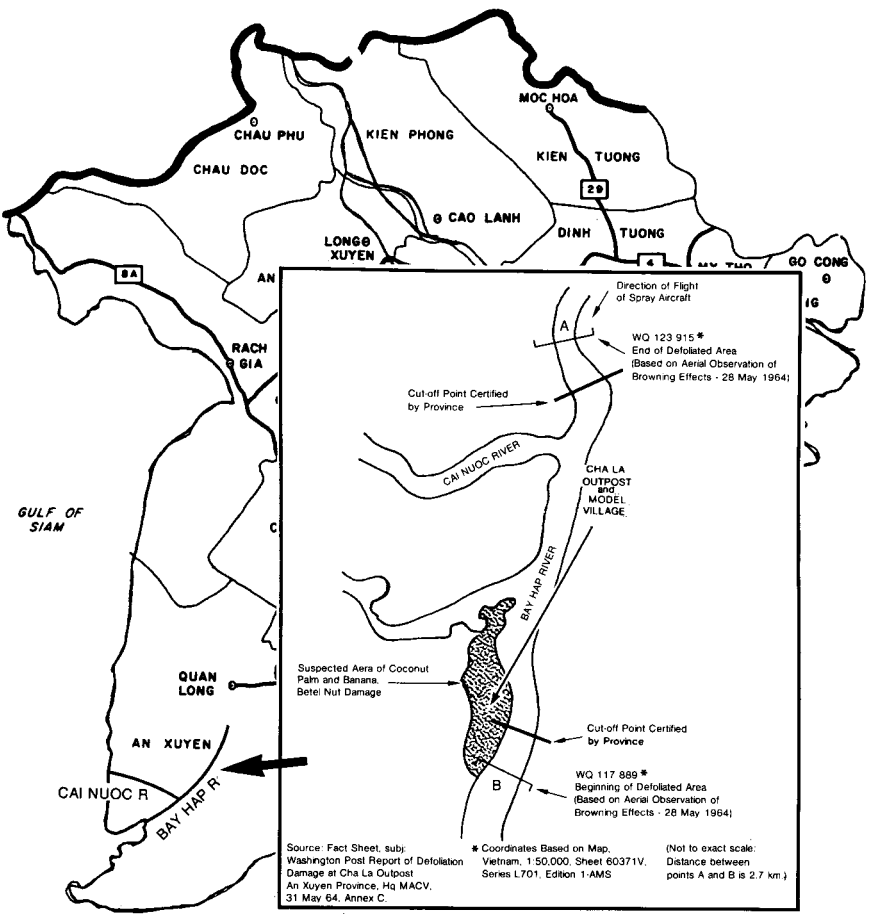
> CHA LA, Viet Nam, May—Two weeks ago, at six in the morning, an Air Force plane swept low over Cha La.
>
> What followed was one of the more tragic mistakes of the war.
>
> Numb with shock, Maj. Victor Chandler, Austin, Tex., watched as it whipped back and forth over the rice paddies and pineapple groves on which Cha La depends for its prosperity.
>
> Vic Chandler did not need to be told this was a defoliation plane. Nor did he need to be told the pilot had misread his map. Plant killing chemicals, intended for enemy country deeper south, sprayed the ground below. Chandler's shouted protests went unheard.
>
> That, Col. Jim Keirsey, Durant, Okla., senior advisor to a Vietnamese division, said grimly later on, was the last defoliation mission flown on the Ca Mau peninsula. It will be until we get some things straightened out. But that does not save Cha La's paddies and pineapple groves. Today, their green is slowly turning to brown and the months ahead look bleak indeed. . . .[11]

The *Washington Post* printed the Lucas story, edited to change the style but with the main allegations still intact, on May 26, 1964. On the following day, the paper published this editorial:

> The miscalculation that caused the destruction by defcliants of crops in a friendly South Viet-Nam village has again called into question the wisdom of using such agents at all in this kind of war. This sort of unselective and nondiscriminatory warfare, like the use of napalm and similar weaponry, simply is not suited to the pursuit of guerrilla infiltrators. We are burning the barn to get at the rats.
>
> The employment of the devices of chemical warfare even in enemy country where the inevitable hardships fall upon the enemy's civilian population is open to all sorts of ethical doubts. Their employment in a civil war, where the consequences are visited upon a civilian population we are trying to defend is folly compounded.
>
> Their consequences of employment by error and miscalculation is simply terrible. But we can avoid the results of error, in the employment of these weapons, by not using them at all in an environment for which they are totally unsuited.[12]

Reaction from the Pentagon was immediate. On the afternoon of May 26, the Joint Chiefs dispatched a message to Admiral Felt and General Harkins which outlined the Lucas story as published by the *Washington Post* and directed these military commanders to provide Washington with

CHA LA DEFOLIATION AREA
AN XUYEN PROVINCE



details on the Cha La incident.[13] Two days later Saigon's initial reply confirmed the Lucas story as "basically true but not [the] whole truth." MACV explained that the original request from the ARVN corps headquarters had asked for complete defoliation on both sides of the canal, including the hamlet of Cha La, but that U.S. military representatives had influenced the Vietnamese to establish spray cutoff points to protect a regimental headquarters and the adjacent Cha La "new life" hamlet. The message went on to say that two Ranch Hand C-123s had been flying in formation while spraying near Cha La with the lead aircraft navigating and the pilot of the second aircraft starting and stopping his spray based on what he saw the lead aircraft doing. When the lead aircraft shut off its spray approaching Cha La, the pilot of the second aircraft did not immediately see it stop because of fog, haze, and the generally poor visibility at dawn, and he continued his spray momentarily before shutting it off. In a debriefing after the mission, the crew of the second aircraft said that even considering their delay in stopping the spray, they did not feel that herbicide had carried across the authorized cutoff point north of Cha La.[14]

A follow-up report from MACV on June 3 said, based on detailed U.S. air and ground reconnaissance, that the Ranch Hand planes had not sprayed Cha La after all and that there was no plant damage at Cha La as of June 1 that could clearly be attributed to herbicides. The report cautioned, however, that there was some browning of about fifty coconut palm, banana, and betel nut trees that may have been caused by herbicide drift, but no firm conclusion could be drawn for about 30 days. Casting further doubt on Lucas' story, MACV's follow-up report stated that there had been no damage to rice and pineapple, as claimed by Lucas, and that, in fact, the area around Cha La which Ranch Hand had allegedly sprayed by mistake contained no such crops.[15]

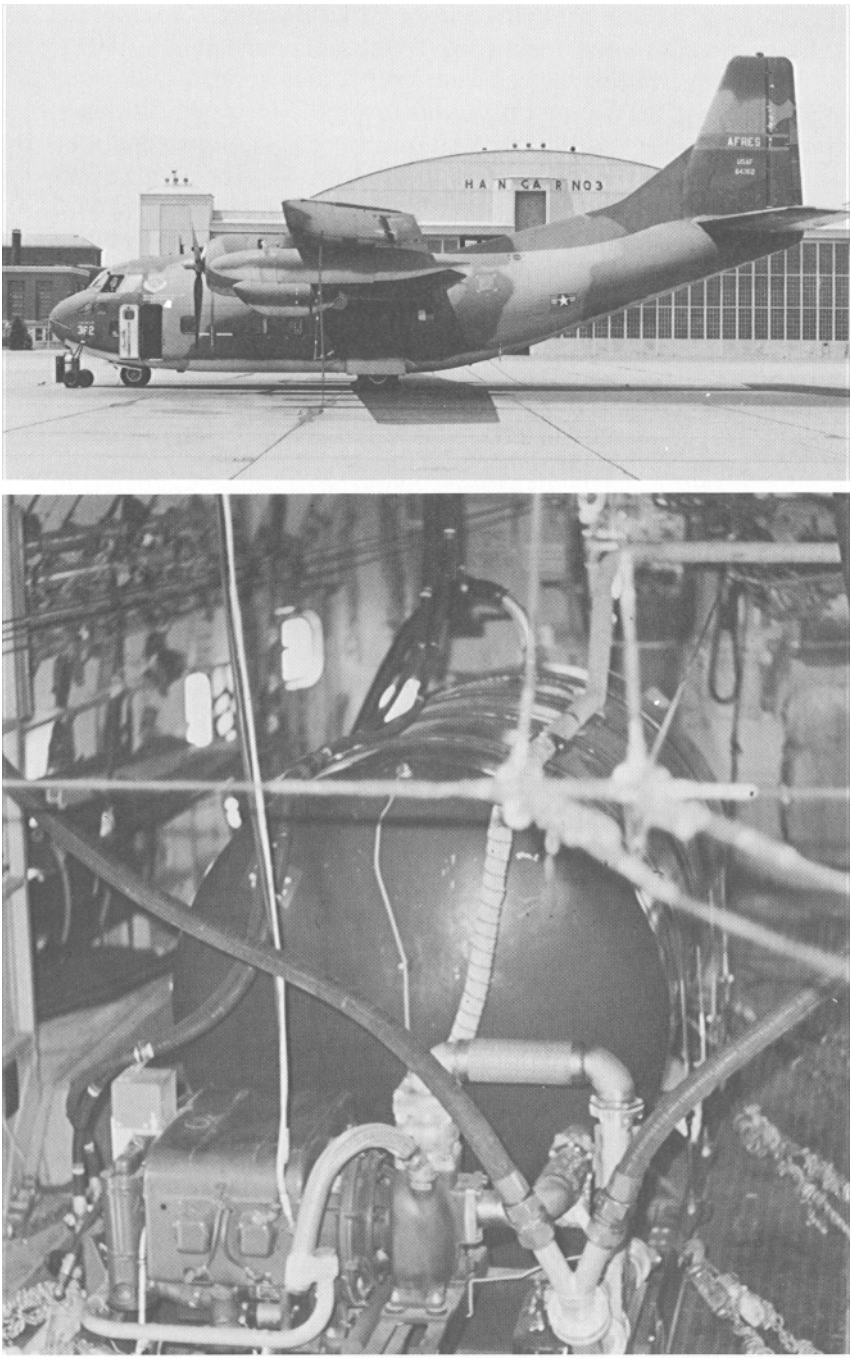
On June 9, 1964 a South Vietnamese official visited Cha La and paid indemnification to 57 residents of the village and the surrounding area for their claimed loss of 5,569 coconut and areco nut trees. These trees were both inside (where damage had been expected) and outside the authorized spray target area. American officials had urged the South Vietnamese to make the payments promptly without subjecting the claims to a prolonged investigation, even though it was highly probable that many of them were illegitimate. The residents of the area were reportedly highly satisfied with their government's handling of the situation, and MACV noted that in contrast to their past reluctance to make such payments, South Vietnamese officials had paid for defoliation damage at Cha La promptly and completely.[16]

A very important factor affecting Ranch Hand in the performance of its mission over Cha La and the related Delta targets in early 1964 was a serious increase in the quantity and effectiveness of Viet Cong ground fire. Prior to late 1963, Ranch Hand crews reported ground fire as a constant potential harassment, but it was never concentrated nor accurate enough to

seriously interfere with the spray mission. That this threat was low was due to the location of targets, security of target areas provided by ARVN troops on the ground, and Viet Cong inexperience in antiaircraft tactics. After late 1963, however, Ranch Hand planes faced greatly increased resistance during spray runs. The South Vietnamese government was losing control to the Viet Cong in many areas, particularly the Ca Mau peninsula which experienced the most rapid rate of deterioration. Heavier infiltration of enemy forces into previously secure areas, meant that larger numbers of ARVN troops were needed to occupy and suppress ground fire from future Ranch Hand targets. However, due to the increase in enemy activity throughout the country, ARVN commanders not only could not assign additional troops to support the defoliation mission, but even had to withdraw those forces previously used to secure Ranch Hand targets and assign them to other missions. Fighter escorts were the sole source of target security during 1964. Ranch Hand encountered Viet Cong forces in larger concentrations, and, with practice, the Viet Cong's proficiency in antiaircraft fire increased.[17]

Ranch Hand C-123s began spraying a four-target complex of rivers at the extreme southern tip of the Ca Mau peninsula in the middle of April 1964. This group of targets included the Cha La area discussed earlier. The Viet Cong had controlled two of the target areas for more than three years, and in an attempt to reduce the effectiveness of ground fire, Ranch Hand crews utilized the recently developed "pop-up" tactic. This tactic involved flying at the extremely low altitude of 20 feet over the flat Delta land between spray targets, climbing to the 150-foot spray release altitude just before reaching the spray-on point, and descending again to 20 feet in order to exit the target area. Before April 30, this tactic was able to keep the average number of hits to about three to five per mission.[18]

On April 30, 1964, Ranch Hand flew a spray mission against a target in the Delta which they had selected from the approved list after Maj. Gen. Joseph H. Moore, the commander of the 2d Air Division (Air Force headquarters in South Vietnam), asked them to pick a spray target where they could guarantee that they would receive ground fire. A special escort of four VNAF A-1 fighters, each with a single VNAF pilot, and four VNAF T-28 fighters with mixed USAF and VNAF crews was authorized for this mission. The fighters rendezvoused with two Ranch Hand C-123s about an hour before sunrise over Tan Son Nhut for the flight south. At first light they arrived over their target, a canal. Capt. Charles F. Hagerty, the Ranch Hand commander at that time, flew lead, and Capt. Eugene D. Stammer piloted the second aircraft. One plane sprayed one side of the canal; the other took the opposite bank. Ranch Hand's promised ground fire, much more intense than expected, burst forth near a small village. Just as they reached the village, Captain Hagerty felt what he thought was his airplane exploding. Two .50-caliber machine guns, one on either side of the canal, opened up on his lead aircraft and "walked" it down the canal in a



Top: "Patches," prior to its retirement, 1979; bottom: an A/A45Y-1 internal spray system mounted in a UC-123K.

a flare were set off by a projectile penetrating the cargo compartment, the crew chief would be able to kick the burning flare out the rear door rather than leave it trapped within the fuselage.[20]

Twice during May and June 1964 Ranch Hand shifted its base of operations north to Da Nang while waiting for further targets in the Delta. The cooperation of the host base enabled Ranch Hand to move and be ready to begin operations in one day. The targets sprayed from Da Nang were mainly winding mountain roads which connected South Vietnamese outposts along the Laotian border. The Ranch Hand crews changed their tactics against these targets which were located between mountains and had variations in elevation of up to 1,500 feet, quite distinct from the targets they were used to spraying in the flatter terrain further south. To increase maneuverability and climb performance, crews reduced the C-123s' weight and fuel loading as much as could be tolerated. They also flew the runs with the downhill slope of the targets whenever possible. Uphill targets were difficult and demanded extreme caution, requiring climb power to full power at all times and leaving little margin for error. Ranch Hand was able to rapidly reload the aircraft between sorties, reducing turnaround time to about ten minutes per aircraft. This enabled the unit to fly as many as six sorties in a three-hour period with only two aircraft. They used this capability to advantage on four of the mountain targets, completing them in one morning where they would normally have needed two to three days. Because the Viet Cong could not move their forces in such a short period of time, the spray planes received little ground fire and sustained only four hits on the total of 26 sorties flown from Da Nang.[21]

In July 1964 Ranch Hand shed the temporary duty status it had retained for almost three years and became Detachment 1 of the 315th Troop Carrier Group, a unit permanently assigned to Southeast Asia. Debate about whether the Ranch Hand project would end had delayed the decision, but by the middle of 1963 it had become evident that the herbicide spray mission would remain a part of the U.S. effort in South Vietnam. Accordingly, on July 1, 1963, the three Ranch Hand spray-equipped C-123s had been transferred from TAC to PACAF. In December 1963, Headquarters USAF had directed TAC to establish a training program for pilots and ground personnel to give them the specialized training necessary to perform the aerial spray mission. The training program included a maximum of 30 hours of familiarization flying and contributed to the orderly transfer of operational and support responsibilities from TAC to PACAF. TAC instituted this program at Langley AFB, Virginia, where experienced spray pilots from the Special Aerial Spray Flight trained the replacement spray crews. PCS personnel gradually replaced the TDY people from TAC during 1964 so that by the end of the year, Ranch Hand was a permanent unit.[22]

Ranch Hand returned its base of operations to Saigon in July 1964 and resumed spraying the Mekong Delta target discontinued on April 30 because of ground fire. The 1½ gallons per acre applied in late April had

been ineffective, and the target had to be resprayed. Before flying these missions over the Delta, an open-topped box, three feet on each side, constructed of two ½-inch thick sheets of Doron armor was installed at the spray operator's position to afford him some protection against ground fire. Ranch Hand scheduled and flew missions at uneven intervals to confuse enemy gunners, but in spite of this, the intensity of ground fire increased. The Viet Cong by this time exercised total control over some parts of the Ca Mau peninsula, and they had many modern weapons, such as .50 caliber machine guns captured from South Vietnamese forces, removed from downed fighter aircraft, or supplied to them by communist countries supporting their insurgency. Ranch Hand completed the re-spray of these areas on July 22, but not without taking hits on every mission, including 14 on each of two aircraft on July 16.[23]

One of the limitations of Ranch Hand equipment which contributed to the ground fire problem was the necessity to spray each target twice to obtain the desired three gallons per acre deposition rate. One pass with the existing system delivered only 1½ gallons per acre. The Viet Cong could count on the aircraft returning to a target for the second application of herbicide, and this enabled them to prepare a "welcoming party" of antiaircraft fire. In 1963 PACAF requested the development of a new spray system which would deliver three gallons per acre in one pass. This new system, known as the A/A45Y-1, incorporated spray booms under each wing, a boom under the tail, and a larger 28-horsepower pump which increased the pressure from 38 to 60 pounds per square inch and boosted the herbicide flow rate from 170 to 280 gallons per minute. Its first successful flight test in Vietnam was conducted on August 15, 1964. After the test, Ranch Hand personnel operated the system without the tail boom because they felt the marginal increase in herbicide coverage it offered did not justify its added weight and drag. They had also noted in the test that herbicide dribbled out of the tail boom for about three minutes after the spray was shut off and might cause inadvertent crop damage. In later years, however, a tail boom was used with the system.[24]

After the arrival of the A/A45Y-1 system, Ranch Hand continued its defoliation spray work. The unit flew 31 defoliation sorties along Route 14 with the new system and also did more spraying in the northern part of South Vietnam before the end of 1964. Ranch Hand's defoliation sorties for the year totalled 363. In addition, they flew 72 reconnaissance flights. These figures reflected an average 1964 utilization rate of 55% of Ranch Hand's maximum capability of 22 sorties per aircraft per month. However, from September through December of that year, Ranch Hand's three C-123s had flown at 92% of their maximum capability—a result of the decrease in the restraints applied by policymakers to defoliation after it became clear, early in 1964, that South Vietnam would collapse without a major military commitment on the part of the United States. The "limited war" in Vietnam was becoming much less limited, and Ranch Hand's operations reflected

this change. By the end of the year a fourth spray-equipped C-123 had arrived to increase Ranch Hand's capabilities, and plans in existence in December were extensive enough to keep these four planes fully occupied for the first three months of 1965. The plans embodied a bolder approach to defoliation, one oriented more toward Viet Cong base areas and toward preventive rather than corrective spraying along threatened lines of communication.[25]

The guidelines issued in May 1963 had seemed to clear the way for chemical crop destruction operations, subject only to Washington approval for each target. However, the turbulent political situation in Saigon after late 1963, the lengthy delays built into the approval process, and the reluctance of the VNAF to fly helicopters into areas not previously secured by ground troops combined to delay any resumption of chemical crop destruction operations for a full year.[26]

The first attempt to use the approval procedure established by Secretary Rusk's directive of May 7, 1963 occurred in the following month. On June 19, the American Embassy in Saigon forwarded an urgent request to the State Department for authority to use helicopters and hand sprayers to chemically destroy some 3,000 acres of small- to medium-sized plots of manioc and potatoes growing in a Viet Cong-controlled area in Binh Dinh and Quang Ngai provinces. The timing of this spraying, planned in conjunction with an ARVN search-and-clear operation scheduled to conclude in mid-July, necessitated a rapid response from Washington. The Embassy assured the Secretary of State that the crops were in a stage of growth susceptible to herbicides and that the use of chemicals would merely be an extension of routine food denial operations by manual means. The officials in Saigon also promised Washington that psychological warfare and civic action plans then being developed by the Vietnamese would be completed before launching the operations.[27]

In a memorandum to Michael Forrestal at the White House on June 20, 1963, William P. Bundy restated the Saigon request and added the strong endorsement of the Department of Defense. He noted, however, that the State Department planned to defer its approval for diplomatic reasons. On July 6, U.S. Marine Maj. Gen. Victor H. Krulak, in a report on a recent visit to Vietnam, stated that these crops would be killed one way or another and that the use of herbicides would free ARVN troops from the tedious task of destroying the crops by hand. General Krulak also observed that Vietnamese forces already possessed the necessary chemicals, sprayers, and helicopters and thus had the capability to conduct defoliation and crop destroying herbicide missions on their own without the consent of the

United States. Only by a gentlemen's agreement did the Vietnamese recognize an American veto over the use of herbicides and associated equipment. He cautioned that future divergences between the U.S. and South Vietnamese viewpoints could lead to the use of herbicides by the South Vietnamese with neither the knowledge nor consent of U.S. officials. The objection of the State Department, however, to the use of herbicides in this instance evidently carried the day. The Olenchuk Report mentioned no chemical crop destruction in the area and noted that the request was still pending in October. At the same time, Olenchuk reported that 1,336 acres of crops had been destroyed manually in III Corps during May, June, and July 1963.[28]

In 1964, the restraints placed on chemical crop destruction by Washington officials, fearful of the potential domestic and international outcry against the tactic, slowly crumbled. On January 12, Ambassador Lodge received authorization from Secretary of State Rusk to use herbicides against crops in Zone D. However, each operation had to gain the personal approval of the Ambassador and one of the three leading generals in the South Vietnamese Military Revolutionary Council or the South Vietnamese Prime Minister. And, Rusk cautioned Lodge to respect the requirements established in May 1963 in regard to civic action, psychological preparations, and compensation and relief machinery. Secretary Rusk ended on a positive note by saying that " . . . we [are] prepared to consider delegating to you authority to initiate operations in other similar areas under Viet Cong domination subject to the same U.S. and GVN controls. . . ."[29]

On February 18, the Joint Chiefs of Staff recommended a series of actions to improve the South Vietnamese position in light of a very pessimistic intelligence estimate issued on February 12 which concluded that without marked improvement in the South Vietnamese government and armed forces, South Vietnam had, at best, an even chance of surviving the Viet Cong threat in the coming weeks and months. High on this list of actions was an intensification of the use of herbicides for chemical crop destruction.[30] Saigon did finally receive limited additional authority to spray twelve more areas in mountainous regions of South Vietnam on March 3, and authority to spray five additional targets in Binh Thuan and Phu Yen provinces in early July.[31]

The requirement that highest level South Vietnamese officials give their personal approval to each individual crop destruction mission added a great deal of delay and complexity to the process of planning and executing crop destruction missions. Frequent changes of leadership in the Saigon government in early 1964 made obtaining this approval difficult. To reduce delays, on July 24, ten days after relieving Ambassador Lodge, Ambassador Maxwell Taylor asked the State Department "as a matter of urgency" for the authority to approve, under existing guidelines, crop destruction missions anywhere in South Vietnam.[32] Secretary Rusk agreed to Taylor's request on

July 29, 1964. Cautioning that "crop destruction remains [a] matter of serious political concern here and political aspects must be given careful consideration by Saigon . . . ," Rusk continued the requirement that each operation be personally approved by a senior South Vietnamese official. He did, however, remove the need for approval from Washington for each target.[33]

Chemical crop destruction missions flown by VNAF helicopters resumed in South Vietnam in May. From then through October, these helicopters flew 128 herbicide sorties, destroying an estimated 6,434 acres of Viet Cong crops. There were serious problems with the HIDAL spray system, however, caused by poor maintenance and mechanical failures, and, American evaluators felt, by a lack of motivation among the VNAF crews. As noted before, VNAF pilots, because of the vulnerability of their helicopters, refused to spray areas not previously secured by ground forces. These factors combined to prevent the spraying of several Viet Cong production areas. Nevertheless, a 1964 MACV evaluation of the impact of crop destruction rated it as by far the most effective of the two herbicide programs. The Viet Cong and their supporters, according to MACV, were disillusioned and confused by the crop destruction. Food production had fallen, straining their ability to be self-supporting, and several hundred people from sprayed Viet Cong areas had returned to South Vietnamese government control.[34]

Before late 1964, American reluctance to allow the South Vietnamese to conduct chemical crop destruction operations was accompanied by an even stronger opposition to any direct American participation in such operations. But, the weakening of restraints against South Vietnamese operations was followed by a crumbling of barriers to American participation. As late as March 10, 1964, Secretary McNamara at a meeting in Saigon had reconfirmed the decision to keep the U.S. out of direct involvement in chemical crop destruction. Gen. Maxwell Taylor, soon to become Ambassador to South Vietnam, had commented, at the same meeting, that if at all possible, marked USAF aircraft should not fly this type of mission, and that equipping a VNAF C-47 with spray gear should be explored.[35]

Circumstances forced the General to change his mind after he became Ambassador. The VNAF refused to use their helicopters to spray two potentially lucrative targets—Viet Cong food production areas in Phuoc Long Province and Zone D. Ambassador Taylor ordered Ranch Hand to destroy these crops using the Farm Gate concept, meaning that the Ranch Hand planes would carry temporary South Vietnamese markings for these missions and would be ostensibly under the control of a South Vietnamese "aircraft commander." President Lyndon B. Johnson had given Ambassador Taylor a very broad grant of authority when he sent him to South Vietnam, and this, plus deepened American commitment to the war after the Tonkin Gulf Incident in August, probably explains the lack of debate and discussion between Washington and Saigon on this decision.[36]

On October 3, 1964, Ranch Hand began its first crop destruction project. Called "Big Patch," the spray planes flew 19 sorties between October 3 and 13 against fields near War Zone D. During November and December, the C-123s flew 15 crop destruction sorties in Phuoc Long Province as part of operation "Hot Spot." Ground fire was heavy on both projects, with the planes taking 40 hits from the ground. Despite the resistance, the unit destroyed 7,620 acres of Viet Cong crops (or, more precisely, crops alleged to have been destined for Viet Cong consumption) and MACV rated Ranch Hand operations against crops highly successful.[37]

If some of the proposals put forth in 1964 had been accepted and translated into policy, Ranch Hand crop destruction activities might have been much more extensive. On Februrary 21, 1964, General LeMay, Air Force Chief of Staff, suggested to the other members of the Joint Chiefs a multifaceted program to "revitalize" the counterinsurgency campaign in South Vietnam. In light of the pessimistic intelligence estimates of the situtation, he was convinced that bolder, and immediate, actions had to be taken if the war were to be won and the spread of communist influence in Southeast Asia halted. He felt that the United States should state clearly that it was prepared to continue its involvement in Vietnam and, although there was no need to precipitate an increase in the level of conflict in Southeast Asia, the Administration should be prepared to escalate its efforts if necessary to achieve its objectives.

Following his analysis of the situtation, LeMay submitted an outline plan for discussion by the Joint Chiefs and eventual forwarding to the Secretary of Defense and the President for their approval. He advocated a strong public statement of U.S. policy in Southeast Asia to affirm an American determination to assist the South Vietnamese government in destroying the Viet Cong threat; to reject any compromise on the U.S. objective to insure a free and independent South Vietnam; and to explain to the American people the nature of the risks involved and the necessity of victory in South Vietnam to prevent communist advances elsewhere in the world. After this, LeMay listed some six pages of recommendations for overt and covert military actions in support of this restated policy. As could be expected, many of them involved air power: introducing jets into South Vietnam; increasing reliance on air mobility of ground forces; and conducting airstrikes in Cambodia, Laos, and North Vietnam. Among the covert military activities he suggested was the use of South Vietnamese personnel trained and equipped by the Central Intelligence Agency (CIA) or the U.S.

crossfire. The crews also reported possible air-burst mortar fire. On Hagerty's plane, one of the two engines was hit. Hagerty immediately feathered it and dumped the remaining herbicide load while climbing for altitude. Another round of enemy fire came up through the oxygen regulator, penetrated the right armrest, and disintegrated in the copilot's parachute where it started a fire, indicating that it was probably a tracer round. The copilot was burned, and the navigator received minor scratches while beating out the fire in the copilot's parachute.

Captain Stammer also immediately turned off the target, gained altitude, and called for rescue helicopters on ground alert. The accompanying fighters strafed the suspected gun positions and also received .50-caliber fire, although they took no losses. Hagerty nursed his damaged C-123 into an airstrip at Soc Trang, and Stammer landed to pick up him and his crew and take them back to Saigon. They discovered that Hagerty's plane, later known as "Patches," had 40 holes in it while Stammer's plane had 10 or 12 hits, all from .50-caliber guns.[19]

After encountering this serious opposition on April 30, Ranch Hand discontinued operations until May 19. Spraying resumed on that date against a canal located in what was thought to be a secure area 40 miles southeast of Saigon. On the first two days of spraying this target, Ranch Hand received only light ground fire. On the third day, however, the aircraft discontinued their spray run after encountering head-on fire against which they had no armor protection. Ranch Hand requested a fighter prestrike of their target on the fourth day, but this strike, made just before the spray run, missed the target by two miles and was completely worthless except perhaps for alerting the Viet Cong gunners that Ranch Hand was coming. The C-123s received heavy antiaircraft fire during the spray run. The lead aircraft's hydraulic system, (which controlled the herbicide shut-off valves) was disabled and the spray pump and a generator on the number three aircraft were knocked out. The spray planes returned to Saigon and landed without further complication.

After this incident, Ranch Hand requested and received permission to do no further spraying on the Ca Mau peninsula unless they had multiple targets. This change of procedure would allow the C-123s to move from one target to another at their discretion and thereby recover some element of surprise to complicate the guerrillas' deployment problem. They hoped that by not spraying the same target more than two days in succession, there would be insufficient time for Viet Cong forces to congregate in the target area. One item noted in support of their request was that a sudden loss of hydraulic system pressure such as might result from a hit would necessitate the slower manual shutoff of the spray system and might lead to inadvertent damage to crops outside the planned target areas. And to further minimize damage, the unit decided to fly future missions with the rear cargo door pinned open so that if they lost the hydraulic system due to ground fire and

military to destroy North Vietnamese crops in the Red River Delta with herbicides dispersed aerially or spread by agents.* There is no indication that any action was ever taken on LeMay's crop destruction proposal, but the idea of attacking the North Vietnamese rice crop did come up again later that year.[38]

In September, the Defense Department's Office of Foreign Economic Affairs examined the feasibility of economic pressures against North Vietnam, including the crop destruction possibility. This study, prepared by E.R. Van Sant and C.K. Nichols, concluded that although North Vietnam had numerous economic problems, its underdeveloped economy and its isolation from the U.S. and other Western nations limited the areas where effective pressure could be applied. The analysts concluded that discouraging trade with North Vietnam would have only marginal potential, with Japanese imports of coal ($12.2 million in 1962) being the best target.

They also pointed out that North Vietnam had imported $2.2 million worth of fertilizers and agricultural chemicals from the West in 1962, with $1.1 million worth having come from Italy. And, because North Vietnamese agriculture—with a tight food supply constantly under pressure to feed an expanding population—was the weakest part of their economy, these analysts advocated urging Italy to terminate its sales of agricultural chemicals. At the same time, however, they admitted that the impact on North Vietnam would not be great. If higher levels of tension justified such action in the future, the report and a cover letter suggested consideration of the selective use of defoliants to destroy part of the North Vietnamese rice crop. Again, there is no record of any action having been taken on this last suggestion.[39]

In October 1964, Dr. Harold Hall of the Advanced Research Projects Agency suggested an intensive counterinsurgency program in South Vietnam using herbicides to punitively destroy crops in Viet Cong areas of the country. Hall admitted that his idea was controversial and represented a departure from current policy in that his proposal introduced the principle of the responsibility of the local population in areas where the insurgents were strong. Current policy, he said, was based on the belief that the only acceptable crop destruction targets were separate, remote fields known to be controlled by the Viet Cong and that any accidental destruction of other, "friendly," crops had to be followed by prompt restitution. Hall, by contrast, proposed that the South Vietnamese be encouraged to undertake, presumably with U.S. help, widespread and intensive destruction of rice in selected regions where the Viet Cong were heavily dominant. He would

*General LeMay did not discuss how covert agents could obtain and disperse enough chemical herbicides to have a significant impact on the North Vietnamese rice crop, nor did he examine the problems inherent in flying a large number of herbicide sorties at low altitude over hostile territory.

balance this by the defoliation of "wild" lands to replace the sprayed crop lands, accompanied by assistance in homesteading, irrigation, and cultivation of the new areas.

Hall theorized that this policy would combine powerful punishments for unacceptable behavior with equally powerful rewards for acceptable behavior. After the destruction of rice in guerrilla strongholds, the hungry people who lived there would perceive Viet Cong taxes as an explosive irritant. And, the demonstration effect for other areas would, hopefully, make it unnecessary to spray everywhere. Also, hopefully, the implementation of his proposal would provide an incentive to the local population to support the elimination of the insurgents by killing known Viet Cong, reporting their activities, and cooperating with the South Vietnamese government.

Continuing his thoughts, Hall turned to the aircraft needed to destroy one million acres in 100 days. He concluded that 50 H-34 helicopters, 10 C-123s, 10 A-1s, or some equivalent combination of these three types of aircraft could do the job. However, he also forecast that it would not be necessary to spray this extensive an area to induce ". . . 12 million farmers to slaughter the 30,000 hard core VC in their sleep."[40]

Dr. Hall's proposal received some circulation within the Executive Branch,* but reaction was generally negative. Adm. F.J. Blouin, Director, Far East Region, for DOD/ISA, replied on November 7, 1964 that the consensus of ISA, Joint Staff, and State Department personnel who had reviewed the proposal was that it would not be in the best interests of the American or South Vietnamese governments to adopt it and that the concept was neither desirable nor feasible in Vietnam. Admiral Blouin said that the idea of punitive crop destruction was incompatible with inducing the population to support the government, a basic requirement for winning in Vietnam. Noting that relocation would not necessarily separate the people from the freely moving Viet Cong, he further reasoned that destroying extensive areas of crops and moving large numbers of people from their ancestral homes would generate much domestic resistance, external propaganda, and internal criticism. Dr. Hall produced a revised paper in December, but it, too, met with an unenthusiastic reception. The idea of "generating refugees" from Viet Cong areas did, however, gain some acceptance later as following chapters will show.[41]

*The list of officials who saw Hall's proposal or a later, revised version included Harold Brown and Daniel Ellsberg.

VII. Herbicides Reach Their Peak While the War Deepens and Widens

One of the most secure Viet Cong base areas in late 1964 was the Boi Loi Woods, an area of tropical forest about twenty-five miles northwest of Saigon and ten miles from the Cambodian border in War Zone C. Before the South Vietnamese forces could defeat the Viet Cong, such base areas had to be cleared of enemy troops. The ARVN, however, was either unable or unwilling to undertake the long and costly job of clearing and holding the Boi Loi Woods by mounting a conventional ground operation. In a pattern often repeated in the Vietnam war, Americans sought to substitute a technological solution for manpower, in this case, the operation code named "Sherwood Forest"—using defoliants to strip the leaves from the trees of the Boi Loi Woods and later burning the forest to deny the Viet Cong its use as a hiding place.

U.S. advisors in Tay Ninh Province first broached the idea of defoliating the Boi Loi Woods in early October 1964, and a formal request from Vietnamese officials reached Saigon on December 3, 1964. Similar requests in the past had been disapproved because of excessive cost and uncertain practicality, but the Boi Loi request met with success, probably because of the increased availability of resources accompanying the expanded American involvement in the war.

The 18,500 acre area Vietnamese officials requested Ranch Hand to defoliate was thought to shelter one Viet Cong regiment, two village guerrilla units, and about 100 acres of crops. The South Vietnamese government had abandoned its last outpost there in October 1964 and now assumed that the whole area and its people were under Viet Cong control. One of the expected benefits of the defoliation plan was the forced move of the local population into areas dominated by the government, thus denying their support to the insurgency. Accordingly, the South Vietnamese made detailed plans for encouraging the people to leave the Boi Loi Woods through the use of leaflets and loudspeakers and for resettling these refugees in secure areas. The formal request for the defoliation, sent by Lt. Gen. Nguyen Khanh, commander-in-chief of the RVNAF, to Gen. William Westmoreland, COMUSMACV, on December 21, 1964, estimated that about 6,000 people, equally divided between adults and children, lived in and around the target area. About 4,000 people, described as pacifistic, lived in three hamlets and led a difficult life of farming, reclaiming land, and cutting firewood. Another 2,000 people with a very hard life of clearing land for cultivation and cutting firewood lived scattered in the forest itself.[1]

General Westmoreland directed his staff to conduct a feasibility study on burning the Boi Loi Woods, an idea originated by Maj. Gen. Robert R. Rowland, head of the Air Force Advisory Group in Vietnam. On December 17, operations and intelligence specialists recommended against this approach. They pointed out that the forest consisted of non-coniferous broadleaf evergreens which, unlike pines, contained low levels of oleoresin. Without the oil held resins, the trees would not support a self-sustaining forest fire like those which often occurred in temperate zone pine forests. Photographs of the unsuccessful forest fire experiments of February 1962 in defoliated areas supported the argument that any burning would probably end in failure. Nevertheless, the MACV analysts recommended that Ranch Hand defoliation of the Boi Loi Woods proceed.[2] Some other MACV offices held out hope that burning the forest might follow and might work, but on January 1, 1965, the MACV chief of staff, Army Maj. Gen. Richard G. Stilwell, turned the forest fire plan down.[3]

A final revised defoliation request for the Boi Loi area reached MACV through Vietnamese channels on December 22, 1964, and the American Embassy approved it on January 2. Shortly thereafter, coordination meetings arranged for the release of pacification funds for resettling refugees. The 2d Air Division requested that the Boi Loi Woods be declared a free bomb area, and two of the three province chiefs concerned complied,

A Vietnamese soldier sprays fuel oil on underbrush to set fire as a method of vegetation removal.

at least partially. The final operations plan called for preparatory bombing before Ranch Hand flew its defoliation sorties. On January 18, 19, and 20, 1965, USAF and VNAF A-1 fighters dropped over 395 tons of bombs on the Boi Loi Woods to eliminate known Viet Cong positions and harass enemy units stationed there. Although specific points suspected of sheltering VC installations had priority, the planes for the most part conducted area coverage bombing. Riot gas was dropped on hamlets in the defoliation target area to add to the occupants' incentive to leave. Some of the bombs dropped by the fighters used time delay fuses, and refugees later reported that they were very effective in inducing fear because they exploded at times when no aircraft were present. Fears that psychological warfare operations prior to the preparatory bombing would give the Viet Cong time to saturate the area with automatic weapons, before the vulnerable Ranch Hand C-123s appeared, delayed such operations until after the bombing.[4]

Efforts to persuade the bombing survivors to leave the forest began on January 21 with airborne loudspeaker broadcasts from UH-1 helicopters and U-10 airplanes as well as leaflet drops. Notice of the intent to destroy the Boi Loi guerrilla base, South Vietnamese government assurances of financial assistance to refugees, a special appeal by the Cao Dai religious sect for the people to return to their ancestral religion, and instructions on exit routes were included in the messages. The effort was partially successful—2,182 refugees eventually came out of the Boi Loi Woods and surrounding areas for resettlement in territory controlled by the government. In addition to the bombing, many refugees said that they fled the area because of fear that the chemical herbicide was poisonous and would keep crops from growing in the defoliated area for three years. However, the bombing before and during the Ranch Hand mission did take its toll, and estimates placed the number of "VC" dead as of March 20 at 800, plus many more wounded.[5]

Ranch Hand began spraying the Boi Loi Woods on January 22 and continued through February 18. During this period the unit flew 101 spray sorties and delivered 83,000 gallons of herbicides. A-1s continued bombing and strafing the forest while Ranch Hand sprayed, flying 316 sorties, droping 372 more tons of bombs, and firing 85,000 rounds of 20mm ammunition. This unprecedented level of fighter activity was effective in reducing the ground fire threat, and Ranch Hand planes were hit only 79 times, with three crew members sustaining injuries.[6]

The 2d Air Division attempted to resurrect the idea of burning the defoliated forest in a letter to the MACV operations staff on March 12, 1965. The proposal put forth by the division's Director of Operations envisioned saturating the southeast (windward) portion of the Boi Loi Woods with fuel, igniting this area through the use of napalm, white phosphorus, and incendiaries. The wind, it was hoped, would then spread the fire throughout the defoliated area, creating a firestorm effect. The most favorable time for this operation was projected to be during the last two

weeks of March, both to take advantage of the last of the dry season before heavy April rains and to give the forest time to dry out as much as possible after the application of herbicides. The plan proposed by 2d Air Division would use KC-135s dumping fuel from 300 to 500 feet or C-123 and C-130 transports dropping fuel in barrels. Immediately thereafter, fighters would ignite the area. The proposal acknowledged the uncertainty surrounding the success of such a plan, but 2d Air Division urged that it be tried, at least on a limited scale, because of the many factors favoring the destruction of the woods and the valuable experience which would be gained for use in similar future endeavors.[7]

MACV approved the proposal to try to burn the forest this time. 2d Air Division received planning assistance from a Defense Department team which was temporarily in South Vietnam to test the use of forest fires as a tactical weapon against secure Viet Cong base areas. The attempt to ignite the Boi Loi Woods took place on March 31, 1965. C-123 transports carried drums of diesel fuel and in 24 sorties dumped 1,200 gallons each, along with flares to ignite the fuel on impact, over two points on the southeast end of the defoliated area. A-1s flew 29 sorties which each delivered 13 napalm tanks onto the same ignition points. Finally, eight B-57 sorties each scattered eight M35 incendiary clusters in advance of the primary fire so as to induce the fire to spread rapidly throughout the target area.

In spite of the extensive effort to start a self-sustaining fire, the attempt was judged a failure. Shortly after the fires began, a thunderstorm moved through the area dampening them, and another thunderstorm that night extinguished what was left of the fires. There was little fire spreading from the initial points of ignition, a result which had been accurately predicted. Analysts initially blamed the rain for causing the failure, but previous as well as later attempts to burn defoliated jungle proved conclusively that the prevailing vegetation types and high moisture content of the air made it almost impossible to set a self-sustaining forest fire in the jungles of South Vietnam. The U.S. military had to try several times before learning this lesson, however.[8]

Herbicide usage declined somewhat after the Boi Loi operation as an editorial furor developed in the American press over tear gas used during military operations by South Vietnamese forces in December 1964 and January 1965. As a result of this negative publicity over the use of riot control agents, herbicides, which were also chemicals, came under a cloud. The crop destruction program slowed down, while defoliation continued on a more limited scale than originally planned.[9]

On April 30, 1965, Ranch Hand began the largest defoliation project attempted to that time, "Operation Swamp Fox." Swamp Fox covered designated coastal areas of Bac Lieu, Vinh Binh, and Ba Xuyen provinces in the Mekong Delta. Much of the Viet Cong activity in the Delta depended on strongholds, generally immune from attack, where they had training camps, arms factories, repair facilities, and hospitals. Shallow draft sampans could easily bring in supplies and escape aerial detection beneath the foliage of the dense mangrove swamps which covered the area, foliage which herbicides could remove. Defoliation missions against this area flown by Ranch Hand began on April 30, 1965, and continued through May 25. A-1E aircraft from Bien Hoa preceded each Ranch Hand sortie dropping bombs to reduce antiaircraft fire, and forward air controllers assisted by marking suspected automatic weapons positions. These suppression efforts were not entirely successful; Ranch Hand planes were hit 124 times and five C-123 crewmen received minor injuries on the 84 sorties flown over this area. Ranch Hand received orders from 2d Air Division to halt flights over the Delta target complex after spraying only about 70% of the planned area because of the heavy ground fire encountered.[10]

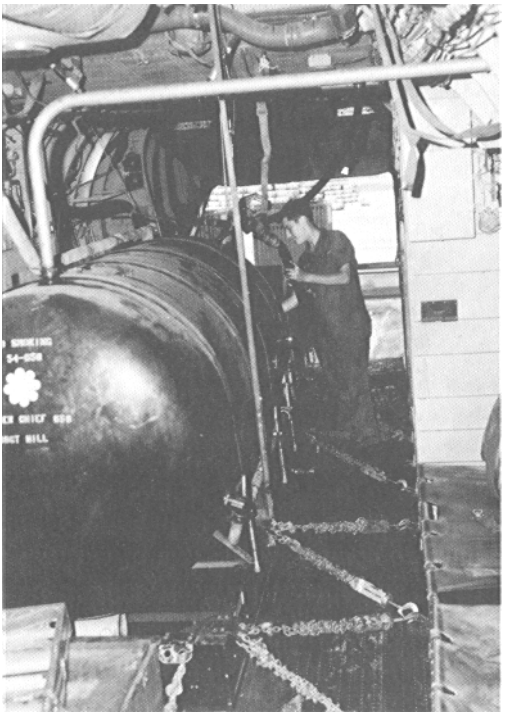
The MACV intelligence staff conducted another evaluation of the benefits of defoliation after cancelling Swamp Fox. The evaluators again concluded that defoliation had great tactical value and was a desirable weapon, but 2d Air Division and PACAF both expressed concern about the safety of Ranch Hand crews. They concluded, after a study of fighter tactics, that the ratio of fighters to spray aircraft needed to be increased along with the fighters' total time over the target. At that time, however, more A-1 sorties, the type best suited for use with Ranch Hand, were not available. Accordingly, on May 25, Ranch Hand suspended defoliation operations for a few months until they had assurance of more A-1 sorties.[11]

During 1965 crop destruction acreage constituted 42% of the total land area covered by herbicides, with the remainder sprayed for defoliation. Although the 65,949 acres of crops sprayed in 1965 was less than a third of the crop area sprayed in the peak year of 1967, the ratio of crop destruction acreage to defoliation acreage peaked in 1965.[12] Washington significantly relaxed controls on crop destruction during the year, making the approval for such operations much easier to obtain. In July 1965, Ambassador Lodge cabled the State Department requesting authority to expand the crop destruction program sufficiently to make a major impact on Viet Cong food supplies. For the expansion, he also requested authority to change the May 1963 guidelines to allow crop destruction operations in more populated and less remote areas of South Vietnam, if the insurgents dominated these areas and if significant military gains would result. Lodge evaluated past crop destruction operations favorably. He concluded that the Viet Cong had suffered considerable hardships from them, while the adverse reactions of the local people had been manageable.[13] He had received a similarly favorable evaluation from MACV, and MACV had published its own positive opinion of crop destruction at about the same time.[14]

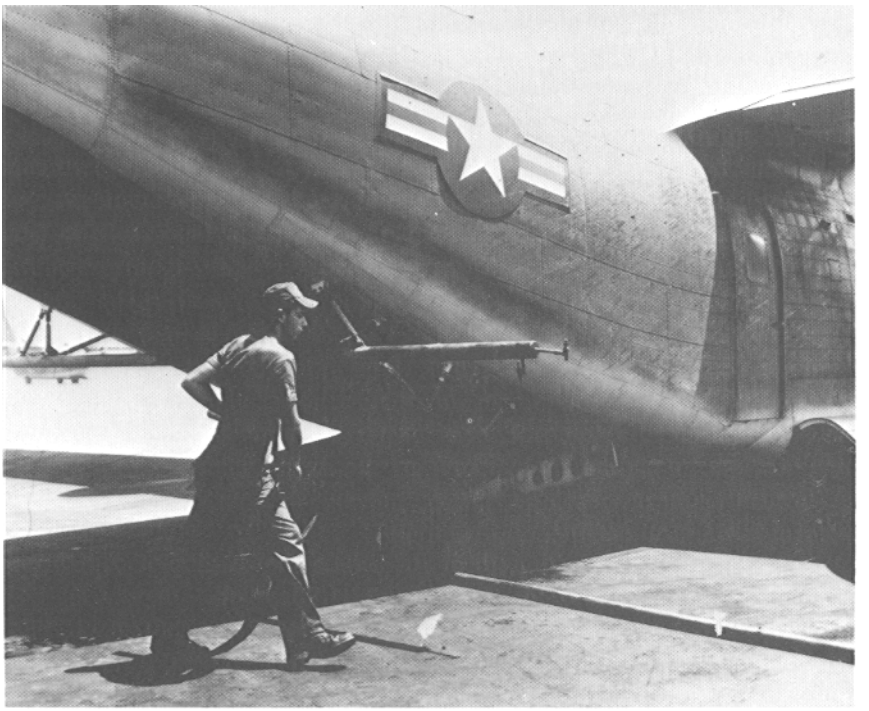
More liberal guidelines resulted from favorable Washington-level action on Lodge's request. The new authority Saigon received on August 7 continued the practice of requiring the U.S. Ambassador and a senior South Vietnamese official to approve, personally, each crop-destruction operation. The message extended the range of permissible targets to include less remote and more highly populated areas where the Viet Cong were experiencing significant food supply problems. The mountainous areas of Central Vietnam and the foothills and valleys immediately surrounding them were specifically included, while the flat coastal lowlands and the southern Delta area where food was plentiful were excluded. Very populous areas where guerrilla control was recent or not firm were to be evaluated on a case-by-case basis, and if the advantages of crop destruction were clearly overriding, Washington authorization for specific targets could be sought. This new authority continued the requirement for a thorough psychological warfare plan for every crop destruction operation.[15]

Ranch Hand flew crop destruction missions in Kontum and Binh Dinh provinces during the middle part of 1965. Between August 15 and September 13, 29 sorties sprayed crops in Quang Tri and Thua Thien Provinces. On October 20, extensive crop destruction operations began in War Zone D and continued until December 17. Ranch Hand flew 163 sorties and sprayed 137,650 gallons of herbicide during these operations. The C-123s received fighter support from F-100, F-5, and A-4 aircraft as well as the familiar A-1E. By November 13, 1965, three more C-123s, spray-modified at the Fairchild-Hiller facility at Crestview, Florida, were in place at Tan Son Nhut with trained crews. This brought the Ranch Hand complement of spray-equipped aircraft to seven. Their designation was changed in that same month to UC-123. By this time, the use of H-34 helicopters for crop spraying had almost totally ceased. Ground forces, however, retained back pack sprayers for use against small plots.[16]

Ranch Hand was steadily expanding its capabilities in line with the general buildup of U.S. forces and equipment in South Vietnam. The expansion brought changes in equipment and tactics. To add some additional protection from the effects of ground fire hits, Ranch Hand crews in late 1965 began using flying helmets with clear visors to reduce the hazard from shrapnel and other flying debris in the cockpit. The tactical changes were instituted to complicate the task of enemy gunners. When the spray aircraft flew over straight targets thought to be defended by undisciplined enemy forces, they flew in a close, nose-to-tail echelon formation. They did not offer such a compact target, however, when they encountered concentrated ground fire or when Viet Cong forces in the target area were well trained. Fighter tactics included prestrike and poststrike passes or a combination of the two. Still, there was the unsettled question of whether a fighter prestrike to disrupt enemy gunners was more valuable than the element of surprise which a fighter prestrike sacrificed.



Top: A1C Richard E. Wolfe, 12th Special Operations Squadron, checks the herbicide level in storage tank aboard a UC-123K; bottom: A2C Ernest C. Bohn, Jr., removes hose after pumping defoliation spray into tanks of a C-123 at Da Nang AB.



Defoliation missions in November and December 1965 included more clearing along lines of communication. A series of 18 sorties along the banks of the Oriental River began on November 25. During those sorties ground fire struck the Ranch Hand planes 34 times. Fighter cover came from forward air controller-directed F-100s, and a "Jolly Green Giant" helicopter stood by for rescue, which fortunately was not necessary. Larger projects began in December in Kien Hoa and Phuoc Tuy provinces and by the time these two projects ended in 1966, they had consumed 130,450 gallons of herbicide. High levels of herbicide usage were stretching the supply system, and, as early as November 1965, a shortage of chemicals forced Ranch Hand aircraft to delay operations—a precursor of more serious herbicide shortages to come.[17]

In December 1965 the Ranch Hand area of operations was expanded to include parts of southern and eastern Laos traversed by the Ho Chi Minh Trail—a complex of roads and foot paths used by the North Vietnamese to infiltrate men and supplies into South Vietnam. The North Vietnamese had significantly increased their use of these routes during the year, as U.S. forces and ground combat activity increased in South Vietnam. Accordingly, stopping or slowing this infiltration through Laos became a major concern.

The idea of using Ranch Hand to fly defoliation missions in Laos initially met resistance from Ambassador William H. Sullivan in Vientiane. On January 11, 1965, Sullivan informed the State Department that he was opposed to herbicides in Laos because of sensitivity among diplomats in Vientiane from nations friendly to the United States over allegations concerning earlier uses of chemical weapons in Laos. Sullivan evidently believed the use of herbicides at that time would have aggravated the situation. In addition, he noted that since virtually all lucrative targets in southern Laos were dispersed under jungle cover, to use defoliants to uncover them would "open a bottomless pit." He pointed out that, in any event, soldiers could keep mobile weapons, such as light machine guns, easily hidden in spite of defoliation. As a substitute for herbicide spray, Sullivan proposed employing low-level oblique aerial photography to gain intelligence on the enemy hidden under the jungle canopy.[18]

Later in the year, General Westmoreland became convinced that there were sufficient targets beneath the jungle canopy in southern Laos to justify a major effort against the Ho Chi Minh Trail. On November 7, 1965, Adm. U.S. Grant Sharp, CINCPAC, proposed several actions he considered necessary in Laos, one of which was defoliating selected lines of communication and destroying crops.[19] The Secretaries of State and Defense

transmitted their views on defoliation in Laos to Ambassador Sullivan on November 25, 1965. By then Sullivan had relaxed his earlier strong objections to herbicide, probably because of the additional air activity, including B-52 strikes, over the Ho Chi Minh Trail. The fact that the air war had spilled over significantly into this part of Laos would dilute the psychological impact of initiating herbicide missions there. The secretaries approved proposals to defoliate routes in an area defined by Ambassador Sullivan, with the assumption that Prime Minister Souvanna Phouma would approve using herbicides against roads and trails other than the initially approved Route 911. Rusk and McNamara expected a concerted communist propaganda campaign against herbicides in Laos, but they anticipated that this campaign would elicit as little public reaction as had previous communist propaganda on the subject. They directed that any press queries about the use of herbicides in Laos be dealt with according to the standing guidelines—not to report, acknowledge, or otherwise comment on U.S. air operations in Laos except to state that since May 1964 the United States had flown air reconnaissance missions over Laos at the request of the Laotian authorities.[20]

Ranch Hand received final approval to begin herbicide operations against specified targets in eastern Laos on December 1, 1965, and the first spray mission occurred on December 6 over the extreme eastern end of Route 922. Flying from both Tan Son Nhut and Da Nang to spray Laotian targets, Ranch Hand initially sought and defoliated (for improved observation) foot trails which crossed the border into South Vietnam and those which connected with known trails in eastern Laos. This approach was only partially successful due to weather and terrain features. The trails crossed highlands three to seven thousand feet above sea level and the high winds found at that altitude dispersed the spray, causing inadequate herbicide dosages and requiring extra sorties to defoliate the vegetation.

Still plagued by poor cartography, Ranch Hand mapped the Laotian road system from the intersection of Routes 9 and 92 south to Route 923. The intensive mapping effort consumed much time. Most of the roads were under a thick jungle canopy. Where the road could not be seen at all, an "educated guess" provided a probable location for the missing road segments. Reconnaissance after defoliation missions showed that some of these guesses were surprisingly accurate.

Ranch Hand's survey work located more lucrative targets than those afforded by the foot trails. The plotted road network connected North Vietnam to South Vietnam through Laos. Ranch Hand requested authorization to spray these roads, and approval came, on a highly selective basis, beginning in January 1966. By late March, most of Routes 92, 922, 96 and 965 had been targeted and herbicide sorties against them had begun. In early May, Ranch Hand began spray work north of the 17th parallel in Laos, and, for the first time in that country, encountered strong enemy reaction. That reaction included .50-caliber antiaircraft fire on at least five missions.

By June 30, 1966, Ranch Hand had sprayed approximately 1,500 kilometers of roads and trails to a depth of 250 meters on each side—the result of 200 sorties and about 200,000 gallons of herbicides. Fighter pilots and forward air controllers, who often recommended targets, credited the defoliation effort with a major role in the destruction of more than 1,000 trucks which were caught on these roads.

Spraying the Ho Chi Minh Trail in Laos was a difficult job. Even when the crews had accurate maps of the targeted roads and trails, it was sometimes impossible to follow them at the desired spray altitude of 150 feet. Ranch Hand developed three techniques for spraying these roads. The first method involved having one UC-123 fly ahead of and higher than the plane delivering the herbicide. An effective tactic where the road or trail was clearly visible from an altitude of about 1,000 feet, the lead aircraft could follow the road from its higher vantage point, and guide the spray aircraft. After one UC-123 had delivered its load of herbicide, the two aircraft switched roles so that the former lead could spray. Initially one flight of two aircraft would cover a 30-km length of road with one defoliated strip. In about a week, discoloration, easily visible from the air, marked the strip. Two planes could then return and spray together, one on each side of the road, follow the previously sprayed strip and widen the defoliated area to the required 250 meters on both sides of the road.

When the road was not clearly visible from any altitude, except for brief glimpses, the spray aircraft would first fly over the road and throw out smoke grenades at intervals where they could see the road. Only two or three grenades at a time could be strung out as markers or the smoke from the first grenade would dissipate before the UC-123s could fly back to it to begin their spray run. With the jungle canopy in some places reaching 200 feet above ground level, it took about one minute for the smoke to rise to visible height. The Ranch Hand aircraft would then connect the columns of smoke with a strip of herbicide. This second method took a great deal more time than the first, and it was not as accurate. However, it did have the advantage of reducing the risk from enemy antiaircraft fire, since both aircraft were flying at a very low altitude.

The third, and least effective, technique Ranch Hand developed was not used unless the target absolutely required it. Using time and a heading from a known topographic feature, a navigator guided the spray planes over the target. Accuracy suffered because roads were not always exactly where they were plotted on the maps used by the navigator. This method, however, required the least amount of time over the target, and it was therefore the safest to use in the case of roads with known gun emplacements.[21]

At about the same time that defoliation missions began in Laos, General Westmoreland received authorization to conduct crop destruction operations in that country. On May 7, 1966, Westmoreland asked Ambassador Sullivan in Vientiane whether he would approve aerial crop destruction

operations in that country. On May 7, 1966, Westmoreland asked Ambassador Sullivan in Vientiane whether he would approve aerial crop destruction missions in an area traversed by Route 922. On the 18th, Sullivan replied that he had no objection to such herbicide sorties, but he asked to be kept informed of the progress of the operations through the usual Air Attache channels.[22]

Shortly after receiving Sullivan's reply Westmoreland sent a request for approval to fly crop destruction sorties in Laos to his military superiors. He said that air interdiction and defoliation operations had achieved a measure of success in reducing the amount of supplies passing through southern Laos, but that destroying crops being grown in enemy-controlled areas would greatly aid the overall effort. Westmoreland maintained that reducing the North Vietnamese Army's ability to live off the land would further tax the North Vietnamese supply and transportation system, and their morale would suffer. Based on the analysis of aerial photographs, he proposed a total of 13,800 acres of crops for herbicide spraying. If allowed to grow until harvest the crops might feed 15,000 soldiers for a year. Westmoreland also revealed that his staff was studying other mountainous areas of southern Laos for additional crop targets. Such targets would be submitted for Ambassador Sullivan's approval prior to any Ranch Hand missions to destroy them.[23]

On June 9, 1966, Admiral Sharp approved Westmoreland's request and passed it on to the Joint Chiefs of Staff. On June 18, Sullivan forwarded to Washington a summary of crops in the areas under consideration and stated that crop destruction should take place in one area as a pilot project with results in that area fully evaluated before extending crop destruction operations in Laos.[24] On July 26, the Joint Chiefs authorized Sharp to approve crop destruction targets in Laos subject to the concurrence of Ambassador Sullivan for each target. The JCS also directed that, because of the high sensitivity of all U.S. military operations in Laos, there be no public release of information about crop destruction there. They cautioned everyone to adhere to "sound military security principles" to prevent any accidental disclosures. Ranch Hand later destroyed some crops in Laos, but such missions never became a major part of the herbicide program.[25]

Even as the extension of Ranch Hand operations into Laos were being discussed, debate on defoliation and crop destruction continued, with herbicide usage receiving an overall favorable evaluation from two studies released in the first half of 1966. The first of these, prepared by the RAND Corporation, evaluated Viet Cong motivation and morale. RAND researchers conducted 450 extended interviews with Viet Cong captives and defectors, North Vietnamese troops, and civilian refugees between June and

December 1965. The researchers concluded that the increased level of military activity by U.S. and South Vietnamese forces had adversely affected enemy combat effectiveness and morale. The study assigned herbicides a supporting role in producing this impact. The RAND researchers found that there was a widespread fear of the spray, reinforced by Viet Cong propaganda which stressed its alleged toxic nature. In addition, enemy soldiers tended to avoid defoliated areas because of fear of detection from the air. RAND drew no conclusions about the effect of crop destruction on Viet Cong operations, but the report noted that crop spraying had forced them to abandon their fields in some instances and move to new locations.[26]

MACV and the Vietnamese Joint General Staff, through their Combined Intelligence Center (CICV), produced a more extensive evaluation of herbicide operations in Vietnam a few months later. This report also used the RAND interviews, but in addition it cited information from captured documents and U.S. and ARVN files. The CICV evaluators recognized that doubts existed as to whether the adverse impact of herbicides on the Viet Cong outweighed their adverse impact on the South Vietnamese cause stemming from the possible alienation of Vietnamese civilians. After reviewing the evidence, they concluded that the advantages of herbicides significantly exceeded their disadvantages, and, moreover, this balance was favorable enough to argue for a considerable expansion of defoliation and crop destruction operations.

CICV argued that defoliation had increased the security of U.S. and South Vietnamese installations and lines of communication. Moreover, some disruption had been caused to enemy movement, and the Viet Cong had evacuated some of their defoliated base areas, making them more vulnerable to attack. Defoliation had caused some resentment toward the U.S. and the South Vietnamese government because of the unintentional destruction of civilian crops in the vicinity of spray targets—especially when the affected people did not live under Viet Cong control and therefore expected protection from their government. Again, however, the overall conclusion was that these disadvantages did not outweigh the advantages of the defoliation program.

The CICV analysts also favored crop destruction, but they found more problems of adverse impact with this aspect of herbicide use. They noted that in 1965 herbicides had destroyed enough food to feed about 245,000 people for one year. In many instances, they concluded, the local civilians suffered more than the Viet Cong. In an interview, one former Viet Cong said:

> Almost none of the people understand the purpose of crop destruction by the GVN. They can only see that their crops are destroyed. Added to that, the VC pour propaganda into their ears. Therefore, a number of people joined the VC because they'd suffered from damage.

Another Viet Cong described the negative effects of crop destruction on the morale of people in VC-controlled areas:

> The farmers love their land, and the things they grow. All their lives, they did not own anything better than their own little plot of land, and the few trees. The spraying in one day killed the trees that had been planted 15 or 20 years before. You see how this affects their feelings and morale.

However, a former resident of a Viet Cong area cited the capacity of crop destruction to finally persuade waivering peasants to move to territory controlled by the South Vietnamese government, thereby becoming refugees:

> The truth is, if these people moved to the GVN-controlled areas, it was not only because their crops had been sprayed with chemicals; because since their areas had been hit by bombs and mortars, they had already had the intention to leave; and they would probably have done so, had it not been for the fact that they could not decide to part with their crops. Now that their crops were destroyed by chemicals, they no longer had any reason to be undecided. . . .

CICV maintained that the best evidence of the value of the herbicide program was the Viet Cong's own reports of food shortages and other adverse effects. Two former prisoners of the VC said that their captors complained more about the herbicide program than any weapon used against them. Captured documents revealed that the Viet Cong were concerned over the number of farmers forced by crop destruction operations to move to government-controlled areas. The analysts also stated that enemy troops were generally ordered to fire on spray planes, even when firing might expose their position. On the logistics side, Viet Cong soldiers, forced to carry more food on operations, took along less ammunition. In addition, combat troops had to spend part of their time in food procurement, transportation, or production because of crop destruction. Noting these effects, the CICV analysts concluded that the crop destruction program had significant potential which justified expansion.[27]

At the same time Ranch Hand was flying missions in Laos in early 1966, other spray activity was taking place in South Vietnam. During January, UC-123s flew 130 sorties and delivered 118,500 gallons of herbicide against targets in the Pleiku, Vung Tau, Bac Lieu, Saigon, and Nha Trang areas. Half that amount was used on Laotian targets. The balance changed slightly in February, with 63 sorties flown over Laos and 45 defoliation and 48 crop destruction sorties flown in I Corps.

Interest in using fire as a tool to destroy large areas of jungle had continued and resurfaced early in the year in spite of the disappointing results of the Boi Loi Woods operation. Admiral Sharp had requested the Joint Chiefs to expedite developmental work in this area in September 1965, and,

in December, the JCS authorized the Air Force to conduct another test of the delivery of incendiaries for starting fires.[28] The target selected for the operation was an enemy base area on Chu Pong Mountain near Pleiku, which the month before had been the scene of the first major battles between American and North Vietnamese troops. The area itself consisted of 29 square kilometers of mountainous terrain, rising to 2,400 feet above sea level and mostly covered with a thick jungle canopy.

Ranch Hand's aerial survey of the target revealed that most of the area would have to be sprayed in a loose trail formation, although the southern tip would permit the use of a tight echelon formation. The first defoliation mission over Chu Pong took place on January 24, 1966, with the initial series of 18 sorties ending on February 6. During this time, Ranch Hand delivered 17,000 gallons of orange defoliant.* MACV requested additional spray about two weeks later, and Ranch Hand UC-123s delivered 5,000 gallons of agent blue in five sorties between February 22 and 23. The planes flew along the contours of the mountain and achieved a good spray pattern. No ground fire was noticed.[29]

After allowing the foliage sufficient time to dry, aircraft undertook a massive attempt to ignite the forest. Between 1400 and 1420 local time on March 11, 1966, fifteen B-52s dropped M35 incendiary bombs on the defoliated area. Ten minutes later, eight fighter-bombers delivered napalm on the target. The weather was more favorable than it had been for the Boi Loi Woods operation, with partly cloudy skies, a surface temperature of 80° to 90°, and light winds from the east at eight to ten knots. There was an immediate fire after the initial B-52 bombers delivered their loads and a buildup of heavy smoke. As the B-52s completed their bombing, the smoke column reached its maximum height of 10,000 to 15,000 feet. Smoke obscured the entire target, indicating excellent coverage, but the smoke hid the foliage and prevented an immediate evaluation of the fire's effects. The fighter-bombers dropped their canisters on the periphery of the fire, but the napalm fires did not spread and contributed little to the overall effect. Two days later an aerial reconnaissance flight discovered that this latest attempt to destroy the Viet Cong hiding places by fire had also failed. Only about one-twentieth of the target had burned completely, both tree crowns and underbrush, and these areas were located in valleys. The tree canopy in other areas showed no effects from the fire. There was no improvement in vertical visibility, although extensive burning at lower levels probably had occurred. The results from this test killed the forest fire idea for another year, which, perhaps coincidentally, and perhaps not, was the length of time it took for one set of American officers to complete their tours in Vietnam and gradually be replaced by another group.[30]

*The Air Force began to buy herbicide orange as a replacement for herbicide purple in late 1964. The first orange arrived in South Vietnam in early 1965. See Rprt. Capt. Alvin L. Young, *et al.*, USAF Occupational and Environmental Health Laboratory, subj: "The Toxicology, Environmental Fate and Human Risk of Herbicide Orange and its Associated Dioxin," Oct. 1978, p I-29.

Throughout March, April, and May of 1966, the steady increase in herbicide missions continued. In South Vietnam, Kien Hoa and Phuoc Tuy provinces saw the most action. Ranch Hand flew 116 sorties in South Vietnam and 47 sorties in Laos during March. The number of sorties increased by 20 percent in April, and in May, 218 sorties sprayed targets in South Vietnam, while 26 took place over Laos. In May 1964 Ranch Hand had flown only 20 sorties. This growth of the Ranch Hand mission created both a shortage of herbicide and a demand for more planes. In May, Ranch Hand received authorization for 11 additional UC-123s which would undergo modification in the United States and arrive in Southeast Asia by the close of 1966.

In June, Ranch Hand lost its first aircraft during a combat mission. The UC-123 was hit by ground fire over Quang Tin Province in I Corps. The two aircraft flying this mission had received sporadic ground fire over the target. On their fifth pass, one of the aircraft lost an engine, crashed, and burned on a hedge row near a rice paddy. Six U.S. Marine Corps helicopters responded to the distress call. Two landed at the crash site, in spite of ground fire, and rescued all three members of the crew. The pilot of the downed UC-123 was seriously injured, but the others received only minor cuts and bruises.

An effort to defoliate major Viet Cong base areas began later in 1966 and continued thereafter, partially as a result of Ranch Hand's increased capabilities after acquiring more aircraft. Defoliation of large areas in War

A mountainous area near Pleiku two days after B-52s dropped tons of incendiary bombs to defoliate area.

Zone D began in August. In August and September, UC-123s flew many missions over the Iron Triangle. On October 31, 1966, a Ranch Hand aircraft crashed in the Iron Triangle and, although the plane was totally destroyed, the crew was rescued. Spraying in War Zone C got underway in early September and continued for the remainder of the year. August also saw the start of activity in the Mekong Delta region of IV Corps. Many smaller defoliation targets along roads were sprayed from time to time. By the end of the year, herbicide operations were routinely taking place in all regions of South Vietnam.

Hostile fire was present over most targets, but Ranch Hand's increasing level of operations made fighter cover difficult to obtain during part of the period from September through November 1966. Lack of fighter escort caused cancellation of some missions, especially in III and IV Corps. In August, Ranch Hand received three new spray planes, and four more were added in September bringing the total number of UC-123s available to fourteen. Ranch Hand crews, eager to accomplish as much as possible with the new aircraft, occasionally tried to do too much. Clear weather in the area just south of the Demilitarized Zone (DMZ) in September 1966 allowed Ranch Hand to fly as many as four sorties per aircraft per day. Predictably, the herbicide supply ran low and the planes fell behind on their maintenance schedules. These circumstances forced the crews to stretch out their operations so that maintenance and supply could catch up.

The last quarter of 1966 saw further expansion of the Ranch Hand mission and the unit's establishment as a separate squadron. On October 15, the Special Aerial Spray Flight of the 309th Air Commando Squadron was discontinued and the 12th Air Commando Squadron (ACS) came into being, retaining the code name Ranch Hand which had been applied to USAF herbicide activities in Southeast Asia since 1961. Lt. Col. Robert Dennis was the first commander of the 12th ACS which became a permanent part of the 315th Air Commando Wing (ACW), Troop Carrier. On December 1, the 12th ACS moved its base of operations from Tan Son Nhut to Bien Hoa.

Prior to its redesignation, Ranch Hand took on a secondary mission, spraying insecticide to control malaria carrying mosquitos. This public health mission continued even after herbicide operations ceased in 1971. Employing "Patches," the UC-123 used against locusts in 1962, a test program began in Bangkok, Thailand, on October 14, 1966. Three days later insecticide spraying began in South Vietnam. Workers had stripped "Patches" of all camouflage paint and coated it with an alodine compound to guard against the insecticide's corrosive effects. In the air, insecticide work also differed from herbicide missions. Insecticide missions were longer, making fuel conservation critical. The low rate of application, 8 ounces per acre, enabled one insecticide sortie to cover about 15,000 acres. Insecticide missions, however, did not require the precise navigation of herbicide spray runs. In any event, by the middle of 1967, Ranch Hand was flying about 20 insecticide sorties per month.[31]

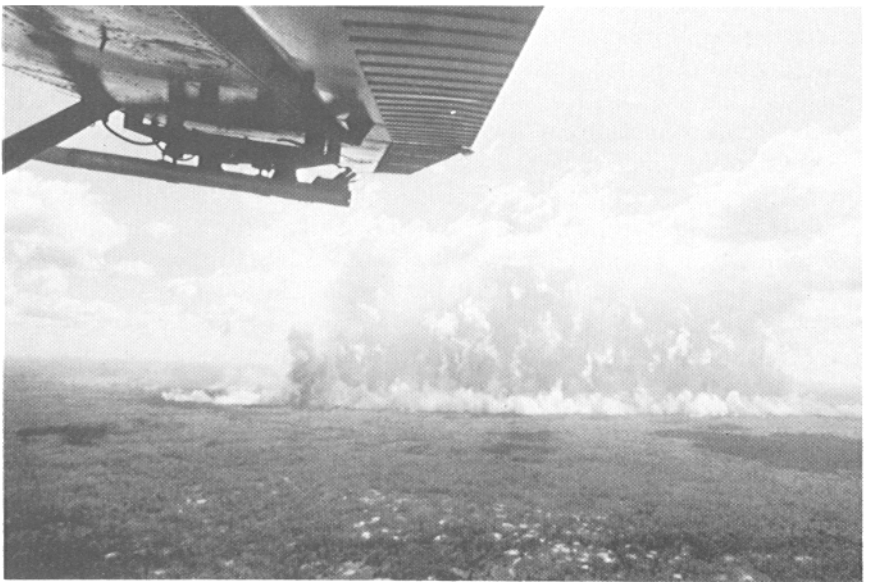
During October, as the insecticide program got underway, the squadron continued its primary mission. Weather conditions hampered Ranch Hand's defoliation activities in the A Shau Valley and near the Demilitarized Zone, allowing increased spraying in Laos. To the south, in Vietnam, they tested the effectiveness of a reduced rate (1½ gallons per acre) of orange herbicide on mangrove trees in the Rung Sat Special Zone (south of Saigon) and in the Mekong Delta. The results were disappointing, and the targets had to be resprayed to achieve the desired results.[32]

In 1966 Ranch Hand received permission to spray an area that, though small geographically, was very important militarily—the southern portion of the Demilitarized Zone separating North Vietnam from South Vietnam. Infiltration by North Vietnamese troops across the DMZ was a significant threat to U.S. and South Vietnamese troops in I Corps. Defoliation there would help to uncover infiltration routes and supply stockpiles. On August 16, 1966, Ambassador Lodge informed the Secretary of State that General Westmoreland had proposed defoliation in and immediately south of the southern half of the DMZ, that is, that portion of the DMZ south of the Provisional Military Demarcation Line (PMDL), all of which was in South Vietnam. Ambassador Lodge had the authority to approve herbicide missions in South Vietnam, but, because of the political sensitivity surrounding the DMZ, he requested both State and Defense Department views on the matter. Recognizing that there were several key military advantages to be realized from defoliation in the DMZ, he expressed three major political reservations: a potential for North Vietnamese charges of chemical warfare, possible adverse impact on efforts to expand the influence of the International Control Commission, and untimeliness.[33]

On August 27, Admiral Sharp endorsed General Westmoreland's proposal. On October 4, the Secretary of Defense wrote the Secretary of State to add his endorsement, noting that the Joint Chiefs also felt that defoliation in the DMZ was highly desirable from a military standpoint. Secretary McNamara said that the North Vietnamese Army had recently sent its 324B Division through the DMZ directly into South Vietnam and was building a supply base in the DMZ for future operations. He cited the fact that defoliation had been conducted in South Vietnam since 1961 and in Laos since 1965, and stated his view that the political risks of defoliation missions in or near the DMZ would be less than the military risks of failing to take reasonable measures to deny the Viet Cong and North Vietnamese Army the use of the DMZ as sanctuary. Including a draft authorization for Saigon, the Defense Secretary asked Secretary Rusk to authorize defoliation missions to begin immediately.[34]

Over a month later, on November 18, Secretary Rusk concurred and agreed to release a modified version of McNamara's draft. Although he foresaw some adverse political reaction, Rusk thought that it would be manageable as long as the spray planes avoided spraying any area in North Vietnam. He also requested the Department of Defense to provide the State Department with complete reports of the progress and evaluation of defoliation operations in and near the DMZ.[35] The message to Saigon, sent on November 26, authorized defoliation operations in the southern portion of the DMZ, subject to the restrictions imposed in the May 7, 1963 guidelines. In addition, the American Embassy in Saigon was required, before authorizing spray missions in the DMZ, to develop procedures to handle the public affairs aspects of the operation and forward those procedures to Washington for approval. The message also directed the Embassy to coordinate with the South Vietnamese government an approach to the ICC which would emphasize how the North Vietnamese continually violated the DMZ and how the U.S. and South Vietnam hoped to reduce the military threat from these violations by defoliating NVA hiding places.[36] The first mission inside the DMZ took place on February 5, 1967, with two UC-123 sorties sustaining no battle damage.[37]

Less than three months later, on April 27, 1967, General Westmoreland requested authority to conduct selective defoliation within the northern portion of the Demilitarized Zone as well as adjacent infiltration routes inside North Vietnam. Admiral Sharp added his endorsement, and, on



In Operation "Pink Rose," B-52s set fires to the heavy growth and destroyed enemy fortifications.

June 12, the State Department granted the necessary approval authority to the American Ambassador in Saigon. The guidelines attached to this authority stipulated that defoliation would avoid populated areas; would not cover large areas which would affect watersheds or create the impression that the U.S. was "laying waste" to a large area; would not damage crops or trees of economic value; and would not kill the trees as concentrations of herbicides had done in South Vietnam. This last restriction was lifted on August 17.[38]

The main areas of Ranch Hand activity during January, February, and March 1967, however, were War Zones C and D, with sortie levels as high as 29 per day. At the same time, across the border, drying roads and infiltration routes brought increased traffic and the spray planes again went into Laos. Increased ground fire there posed a greater hazard for the vulnerable UC-123s, and, on January 31, a Ranch Hand aircraft crashed in Laos. There were no survivors. This was the third UC-123 lost on a tactical mission.[39]

This period also saw the third and last large-scale intentional effort combining defoliation with incendiaries to produce a forest fire in South Vietnam. Codenamed "Pink Rose," the operation involved three target areas, one in War Zone D and two in War Zone C. Each target consisted of a square, seven kilometers on each side, encompassing about 12,000 acres of heavily canopied jungle. Seventh Air Force* coordinated the efforts of personnel from the U.S. Forest Service, Ranch Hand, and SAC B-52 units on Guam.

The three areas, designated A, B, and C, had received their initial treatment of herbicide by November 27, 1966. Ranch Hand covered areas A and B with orange, while spraying area C with white, a new mixture introduced to help alleviate the shortage of orange. The first coverage was at the normal rate of three gallons per acre. It was followed by a second dose of the same herbicides in January 1967. Ten days before the planned ignition, Ranch Hand applied agent blue to areas A and C at the rate of three gallons to the acre, and to area B at 1½ gallons per acre. Aerial reconnaissance of the targets found that the herbicide effects were equal to or better than what had been expected, and inspection teams found good drying throughout. Ranch Hand flew over two hundred UC-123 sorties and sprayed 255,000 gallons of herbicide in accomplishing its part in Pink Rose.

Fires were started in the three areas at different times, because friendly ground forces were operating in the vicinity. The ignition of Target C took place on January 18, 1967, followed by Target A on January 28 and Target B on April 4. Thirty B-52s from the 3d Air Division on Guam delivered M35 incendiary bombs on the first two targets. On the third target, fifteen

*Organized at Tan Son Nhut, April 1, 1966, the Seventh Air Force replaced the 2d Air Division as Air Force headquarters in Vietnam.

B-52s dropped M35s in a smaller, concentrated area to provide an incendiary density three times heavier than that of the first two targets. Coordination on the strikes was excellent. MSG-77 Skyspot radars operating from Bien Hoa and Da Lat guided the B-52s over the targets, spacing them properly.

The weather, overcast over the first target, good over the others, did not influence the course of the fires. The nature of the vegetation did, but the overall results were again disappointing. The burning was ineffective in Target C. Most fires spread no farther than two feet from the ignition point, although some well-drained grassy areas burned well. The results were much the same in Target A. Vegetation in open areas burned well, but the fire did not spread under the jungle canopy. Individual fires set by the incendiary munitions under double canopy jungle spread no more than about six feet, and this meant that only three to five percent of such areas burned. Single canopy jungle burned slightly better, but still only nine to twelve percent of these areas ignited. Almost none of the tree crowns were removed, and later aerial reconnaissance revealed little change in canopy thickness or vertical visibility. Even though the incendiaries in Target B were three times as dense, results there were also negligible. The conclusions from Pink Rose were that an artificially started forest fire was an ineffective technique for removing jungle canopy and that the poor results achieved did not justify the high cost of continued testing.[40]

To maintain the increased activity during this period, the 12th ACS received six additional aircraft, bringing the number of UC-123s available for spray work up to 20. Two of these aircraft arrived in February, one in March, and three in June. Ground fire was a continuing problem, and in addition to the aircraft brought down in January, Ranch Hand lost a pilot to ground fire in May. In the period March through June, Ranch Hand flew most of its sorties in IV Corps, although defoliation targets were also sprayed in II Corps and in War Zones C and D. Some of the missions in II Corps were in support of ground operations, such as "Francis Marion"—a six-month campaign to root out enemy forces from the Central Highlands. By mid-1967, however, Ranch Hand missions were again scattered throughout South Vietnam.[41]

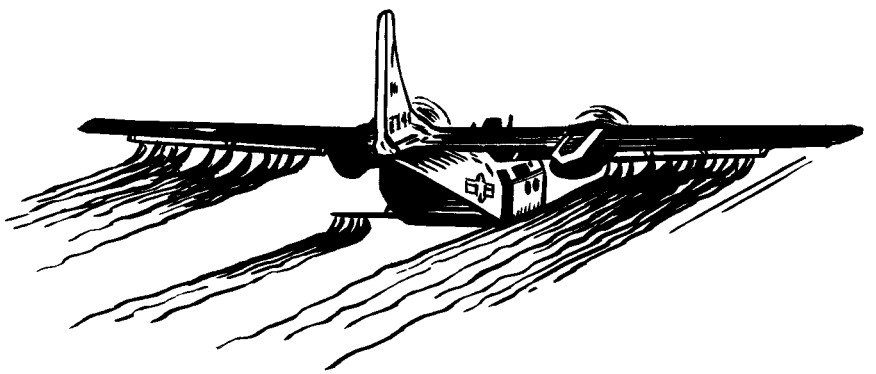
In July, Ranch Hand lost its fourth aircraft downed during a spray mission. The entire crew, three officers and one enlisted man, perished.[42] July was, however, a big month for herbicide delivery, with 435,805 gallons dispensed in 536 spray sorties. Activity increased toward the end of the year, with an average of over 500,000 gallons of herbicides delivered each month during October, November, and December. Between September and November 1967, the 12th ACS established a second operating location at Phu Cat to reduce the possibility of damage to the UC-123s during mortar attacks in their unrevetted parking area at Da Nang. Phu Cat, however, was only a staging base, Da Nang retained its operations, maintenance, and herbicide supply functions. From July to December, Ranch Hand received 296 ground fire hits in 2,856 sorties. Another crew was killed in early September.[43]

To cope with changing conditions and the continuing ground fire threat, the 12th ACS slightly modified Ranch Hand aircraft in 1967. Numerous emergencies occurred which required crews to dump their herbicide. Such action had to be taken very quickly when an engine quit—11,000 pounds of herbicide greatly reduced the single-engine performance of the UC-123. Because of the weight of the chemicals and the infrequency of operation of the dump valve, this valve sometimes stuck. Crews found that in some cases, when electrical system failure forced them to use the manual valve opening system, the cables had become frayed and broke under tension. If all efforts to open the dump valve failed, the only way to remove the herbicide was to run the pump motor at full speed and spray it, a process which took about four minutes. To solve these problems, the dump valve cable was rerouted more directly to the valve, covered in a housing to reduce fraying problems, and the moment arm against which the cable worked was made longer to increase the mechanical advantage. Ranch Hand mechanics also lowered the gear ratio on the electrical dump valve opening mechanism to reduce the load on the electrical motor.

Besides solving the herbicide dumping problem, mechanics installed a system which sprayed water onto the UC-123 windshield to remove herbicide accumulations and enable the pilots to see clearly outside the aircraft, while placement of two mirrors on the glare shield made it easier for them to scan and more rapidly evaluate engine condition while receiving ground fire. The side armor plating which protected both pilots from small arms fire was moved forward and increased in thickness from one half to one inch. For one copilot, this modification took place none too soon. Two weeks later, the armor's new positions and thickness stopped a .30-caliber slug from injuring him. Armor was also placed around the pump motor fuel tank and a fire extinguisher installed nearby to reduce the risk of a ground fire hit causing an internal fire. Another hazard from ground fire, especially for crew members in the cargo compartment, occurred when shrapnel or a bullet punctured a hydraulic or herbicide line and sprayed fluids into their eyes. The squadron's life support section installed bottles of distilled water for first aid treatment in flushing eyes. Finally, Ranch Hand painted a red identification stripe across the top of the UC-123's wings to help fighter aircraft and forward air controllers see the camouflaged Ranch Hand planes more easily against the background of the South Vietnamese jungle.[44]

The use of herbicides in South Vietnam reached a peak in 1967, with 1,687,758 acres sprayed, 85% defoliation, 15% for crop destruction.[45] This high level of activity deserves closer inspection.

The herbicide program, both defoliation and crop destruction, was a joint effort by the U.S. and South Vietnamese governments. The latter exercised its responsibilities through the JGS 202 Committee, composed of representatives from the Vietnamese High Command J-2, J-3, J-4, and J-5 sections, the VNAF, and the South Vietnamese Combat Development and Test Center (CDTC). The 202 Committee met as necessary to consider requests and write directives governing herbicide operations. The American Ambassador and COMUSMACV held the ultimate authority to approve Ranch Hand missions in support of South Vietnamese herbicide projects. The American director of the Combat Operations Center (COC) reviewed plans forwarded from the JGS 202 Committee, and his recommendation went to the MACV 203 Committee for review and evaluation. The 203 Committee was chaired by the MACV Chemical Officer, when Ranch Hand spray missions were considered, and had members from the COC, MACV J-2, the Political Warfare (POLWAR) Advisory Directorate, USAID, the Embassy, and Seventh Air Force. Small-scale herbicide use which employed hand sprayers and ground-based power spray rigs could be approved by senior U.S. advisors at corps and division level without resort to the committee process in Saigon.



Typical herbicide project requests originated with a province chief or a Vietnamese or U.S. ground commander. After review by the JGS 202 Committee, the request went to MACV where the 203 Committee also reviewed it. Then, MACV J-2 and the POLWAR Advisory Directorate provided formal coordination prior to the Embassy's final approval. Once the Embassy acted, the MACV Chief of Staff sent a letter to the Chief of the JGS informing him that the U.S. had approved the project. The Seventh Air Force Tactical Air Control Center (TACC), notified of the project's approval by the MACV Chemical Branch, then directed the 12th ACS to execute the necessary spray missions, after sending out a warning order to field units which might be located in the target area.

During the initial state of coordination, Ranch Hand personnel and a MACV representative conducted a survey flight over the proposed target area. Over crop destruction targets, these survey flights sometimes flew as low as 100 feet to enable the observers to spot fields not visible from a higher altitude. The province chief, MACV chemical officers, Vietnamese military representatives, and Ranch Hand personnel held a coordination meeting early in the approval process. The survey flights and coordination meetings familiarized Ranch Hand with the specific objectives and peculiar characteristics of each project. On the day before the mission, the crews needed only to review the project and plan the spray flight.

One of the most important jobs at the 12th ACS was that of targeting officer. He attended spray project coordination and planning meetings, went on survey flights, maintained a log or chart for all outstanding projects, prepared and updated project folders, and recorded and reported mission results. He also prepared requests for operational orders for the spray planes and their support aircraft and submitted these requests to the TACC five days in advance of each mission. The information submitted to the TACC included the project and target numbers, fighter rendezvous coordinates, FAC rendezvous coordinates, the desired time over target, and special requests such as artillery fire on the target for flak suppression. A report also went to the TACC after Ranch Hand completed each day's missions.

During 1967, as they had done since their early days in Vietnam, Ranch Hand pilots usually flew spray missions in the early morning hours to take advantage of favorable weather conditions. The missions were aborted if the ground temperature in the target area exceeded 85 degrees or if surface winds were greater than eight to ten knots. Higher temperatures might indicate thermal updrafts which would cause the spray to rise, and higher winds could blow the spray away from the target and cause unintended damage to trees or crops in friendly areas. Other aspects of the weather also had to be considered to insure that fighter aircraft flying cover for the UC-123s could operate in the target area.

On operations orders, spray missions were code named "Traildust"; during missions, the spray aircraft used the radio call sign "Hades." Typically, between eighteen and twenty-seven sorties were flown daily, with six

from Da Nang and the rest from Bien Hoa. The number of aircraft assigned to each target varied, usually three or four UC-123s. The UC-123 had a combat range of 250 miles on its two R-2800 radial piston engines. Radios provided UHF, FM, and HF communications capability; an ADF receiver tracked non-directional radio beacons, and a TACAN unit offered more sophisticated electronic navigation. The familiar A/A45Y-1 spray system incorporated a 1,000-gallon MC-1 tank, two wing booms, and a tail boom to provide a coverage rate of three gallons to the acre. Most of the aircraft carried only a pilot, copilot, and flight mechanic, but the lead aircraft also carried a navigator as the fourth crew member. Following the lead UC-123, the planes might spend 45 minutes or more in the target area, but the total spray-on time could not exceed the four minutes needed to empty the 1,000-gallon tank at the desired deposition rate of three gallons per acre. The aircraft delivered the spray at as low an altitude as possible and at an airspeed of 130 knots. One plane could cover a swath 80 meters wide and 16 kilometers long.

Ranch Hand selected the tactics to be used on a specific mission based upon the terrain, weather, and the amount of ground fire expected. On days with clear weather, the UC-123s would cruise to the target at about 3,000 feet above the ground and then descend rapidly about 2,500 feet per minute to the spray-on point. Such rapid descents reduced exposure to small arms fire from the ground. If the clouds were low, the aircraft would fly a low-level approach to the spray-on point. Once over the target, they would fly one long, straight spray run if the terrain permitted. Other possible spray-delivery techniques included flying a race track pattern or a "plum tree" pattern. The latter involved making a 90° turn followed by a 270° turn at the end of the target area.

The fighter support was very important in the success of Ranch Hand missions. If the spray area was "cool," the fighters would fly above the UC-123s and conserve their fuel and ammunition for a more lucrative target. On other targets, a low level "dry run" by the fighters where they delivered no ordnance would be sufficient to keep the gunners on the ground quiet. If Ranch Hand were scheduled to fly a mission against a "hot" target in a free bomb zone, planners might request a prestrike. The fighters would drop CBUs, napalm, or fire 20-mm guns, or do all three. The Ranch Hand aircraft would begin their spray run shortly after the fighter strike while the enemy, hopefully, were still under cover. Intense ground fire could cause the UC-123s to abandon a target after one spray pass and divert to a secondary target. When the flight mechanic observed ground fire, he would toss a smoke grenade out the rear door of the aircraft. The pilot would radio the forward air controller that he had received ground fire from the right or the left, and the FAC would then direct the fighters to the enemy guns—estimating a point some 300 meters behind the smoke to allow for the time needed for the smoke grenade to be tossed and fall to the ground. The forward air controllers also helped the UC-123s correct spray runs.[46]

Due to its long, slow buildup, the herbicide program in Southeast Asia had no immediate effect on the herbicide market in the United States. From 1962 through 1964, only about 250,000 gallons of chemicals had been consumed in South Vietnam. The total U.S. herbicide production in 1965 was about 3.4 million gallons. Some 2.8 million gallons of the total went to agriculture and other non-military pursuits, while the Air Force requirement for that year was only about 400,000 gallons. The use of herbicides as a weapon in Southeast Asia increased, however, and in 1966 a shortage developed, causing projects to be postponed or completed over a longer period of time. Industrial production facilities in the United States, though taxed, were able to fill the fiscal year 1966 (FY 66, Jul 1, 65–Jun 30, 66) military requirement of 1.6 million gallons. The projected requirements for the next two years, FY 67 (5.6 million gallons) and FY 68 (11.9 million gallons) clearly exceeded the existing production capability.

To cover a projected FY 67 shortage of orange herbicide, the Air Force procured 1.5 million gallons of agent white, commercially known as Tordon. Chemically, it was 80% 2,4–D and 20% picloram in a water-soluble formulation. White had the same effect on vegetation as orange, but it acted more slowly. At first, this slow reaction made it less desirable than orange. Later, however, because of the erroneous belief that white was less volatile than orange, it became more popular than orange for targets where drift was a consideration. MACV studied and discarded other proposed remedies for the herbicide shortage, including diluting orange herbicide with 50% diesel fuel.[47]

On January 26, 1967, Secretary of Agriculture Orville Freeman wrote to Secretary McNamara and asked him to have someone in his department look into the herbicide problem. Freeman foresaw tight supplies of herbicide for American agriculture and, consequently, reduced crop yields with accompanying complaints from farmers and other civilian users. At the same time, Freeman wrote to the Director of the Office of Emergency Planning, Farris Bryant, to ask him to assume a role of leadership in allocating existing supplies of 2,4–D and 2,4,5–T and in increasing their production. McNamara's response was to ask the Secretary of the Army to develop a plan to increase production while at the same time asking Bryant to allocate all commercial production capacity for agent orange and its critical components to military use. Bryant agreed to this request and took steps to insure that the entire U.S. output of 2,4,5–T, the limiting component in the production of orange, would be diverted to military requirements. The shortage of herbicides in Southeast Asia peaked in 1967, but the situation never became as bad as had been forecast, primarily because actual herbicide usage never reached the high levels predicted. By early 1969, herbicides were no longer a critical item of supply.[48]

In October 1967, researchers from the RAND Corporation issued two

reports critical of chemical crop destruction in Vietnam.[49] They concluded that the crop destruction program had had an insignificant effect on Viet Cong consumption of rice, while at the same time it had alienated the rural South Vietnamese population from the government. Betts and Denton based their analysis primarily on interviews with 206 former Viet Cong and non-Viet Cong civilians. Most of the former Viet Cong in this group had been in the guerrilla organization between 1965 and early 1967. The analysts made clear at the beginning of their report that there were two possible military benefits of the crop destruction program: the first being a true decrease in the amount of food available to the Viet Cong, the second being an increase in their food procurement costs. Although this second result would have been of great military benefit, especially if the Viet Cong diverted significantly large numbers of men and resources from combat to food procurement, the RAND analysts limited their evaluation to the direct denial of food because, to them, this was a primary reason for the crop destruction program. While Viet Cong food denial was the benefit they studied, the offsetting cost they spotlighted was the increased hostility toward the U.S. and the South Vietnamese government caused by the crop destruction program among the non-Viet Cong rural population of South Vietnam.

The 206 interviews produced findings which the analysts concluded probably reflected the experiences of the Viet Cong and the rural population as a whole. They found that almost all Viet Cong had at least a minimally adequate diet. No variation in their rice rations could be attributed to different intensities of crop spraying in separate areas of the country. In short, RAND found that the crop destruction program had not resulted in any significant food shortages among Viet Cong units.

On the other hand, the researchers found that the spray program aroused much hostility toward the U.S. and its South Vietnamese allies. They cited another study which stated that the guerrillas produced only about 10% of the food they consumed; therefore, a large proportion of the crops destroyed had to belong to civilian farmers in Viet Cong-controlled or contested areas. The interviews pointed out that crop spraying struck at the very heart of a farmer's existence by destroying not only his food supply, but also the product of his labors. The people interviewed also said that there was a widespread belief that herbicides were deadly to humans as well as to plants, a belief based on both hearsay and personal experience. Finally, RAND said that the rural population did not consider the crop destruction operations as necessary or even useful in attacking the insurgency. Instead the people viewed themselves as being targets of the program as much as the Viet Cong government considered them "expendable" if the Viet Cong would be hurt by using herbicides for crop destruction.

In sum, RAND found that the crop destruction program might well be counterproductive. Nonetheless, if continuing the effort were deemed desirable, the U.S. and the South Vietnamese should take more energetic efforts to lessen the negative impacts on residents of the target areas. Both

governments had acknowledged the need for such efforts in the past, but the analysts concluded from their interviews that the levels of information and assistance actually reaching those affected by crop destruction were very low. They recommended renewed efforts to educate the rural South Vietnamese about the effects of herbicides on humans,* to give aid to people whose crops were killed, and to explain that the government sympathized with those innocent people who were hurt by crop destruction, but that the program had been undertaken because of its overall benefits to the country.[50]

The staff of the Assistant Secretary of Defense for Systems Analysis reviewed the RAND findings, and, in November 1967, published their conclusions† which agreed that the existing wholesale crop destruction program in South Vietnam was counterproductive because it alienated the affected population without denying food to the Viet Cong.[51] And, citing the findings of the studies, Secretary McNamara, on November 21, directed the Chairman of the Joint Chiefs of Staff to review RAND's work and report to him within a month whether or not the objectives of crop destruction in South Vietnam were being met, and whether changes should be made in the program.[52]

On December 29, 1967, the Joint Chiefs gave McNamara their reply based on information furnished by Seventh Air Force, MACV, and CINCPAC. In brief, the Chiefs concluded that the published objectives of the crop destruction program as part of the overall economic warfare program were being met; that crop destruction was an important and effective part of the overall effort in South Vietnam; and that no changes in the program needed to be made. In reaching their conclusions, they attacked the validity of the RAND reports on grounds elaborated in appendices.

The Chiefs cited the objectives of the crop destruction program as listed in the 1967 and 1968 joint South Vietnamese–American Combined Campaign Plans. These objectives were not only to deny food to the Viet Cong, but also to divert Viet Cong manpower to food production and to weaken the strength of guerrilla units in the areas where crops were sprayed. The program was successful, they said, in denying food. They cited serious localized food shortages around crop destruction targets along with a resultant Viet Cong belief, in some areas, that they had been economically defeated because they could not logistically sustain themselves. Out of necessity, the Viet Cong and NVA had, in some instances, assigned troops to the tasks of procuring and transporting food, thereby diverting them from combat. In some places, the task of producing rice had become for the enemy as important a mission as waging war. The Joint Chiefs further argued that in some areas of extensive crop destruction, short food rations

*Betts and Denton did not accept the contention that herbicides were completely harmless, and they recommended that people be told to wash the spray off themselves as quickly as possible and not to eat or drink sprayed food or water.

†They later modified their conclusions, however, to conform to the JCS position.

had caused low morale, and a concurrent increase in the number of ralliers to the South Vietnamese cause. It had also caused Viet Cong soldiers to pretend sickness to avoid fighting.

The RAND accusation that the spray program had harmed and alienated residents in the vicinity of crop destruction targets was not so forcefully answered. The JCS claimed that civilians blamed the Viet Cong for the spray because of their "liberation" of the areas. Also, after crops had died in target areas, groups of civilians had moved to areas under government control, further aggravating the guerrilla's manpower problems. In general, the Chiefs argued that almost all crop destruction had occurred in areas which were either uninhabited or under Viet Cong domination. Furthermore, they claimed that the psychological warfare program related to herbicides was important and had been accelerated in 1967.

Although the Joint Chiefs described the RAND studies as "methodologically sound," they pointed out that the studies' limited scope, basic assumptions, and small sample size were weaknesses serious enough to disqualify them as a basis for evaluating the effectiveness of crop destruction or making decisions about the program's future. They noted that 75 percent of the data base used by the RAND researchers had come from Viet Cong whose last service had been in July 1966 or before. Recent changes in tactics and additions to Ranch Hand assets had enabled crop destruction operations to be more extensive and more effective. Because of these changes, the JCS argued that the RAND data was not reflective of present conditions and should not be the basis for current policy decisions. The Chiefs' reply to McNamara countered, for the time being, the threat posed by the RAND analysis to the continuation of the crop destruction program.[53]

VIII. Herbicide Use Declines

In September 1967, the 834th Air Division (AD), the parent unit of the 315th ACW and the 12th ACS, conducted a study of Ranch Hand future needs for men and aircraft. MACV had forecast that, beginning in July 1968, its herbicide spray requirements would increase by about 40% and remain at this new, higher level for at least two years. Ranch Hand then possessed 19 spray-equipped UC-123s, one of which was detailed to insecticide delivery, and MACV thought that an additional seven planes and crews would be adequate to cover the increase in requirements. The 834th AD viewed this level of increase as completely inadequate, arguing that 23 planes were needed just to reach the target of 612,000 gallons of herbicide per month for the current fiscal year, let alone a 40% increase over that. The 834th AD proposed a goal of 32 herbicide delivery aircraft for Ranch Hand rather than the MACV level of 26. Strengthening the 834th AD's argument was the fact that Ranch Hand could not fly in all weather conditions, and sufficient aircraft would have to be available during periods of good weather to make up for cancelled missions.

Besides the eventually approved increase in planes and people for Ranch Hand, the 834th AD also recommended that the Vietnamese Air Force should assume complete responsibility for insecticide spraying and crop destruction missions. Crop destruction aircraft already had to display Vietnamese markings and carry a VNAF crew member on board, and the 834th AD reasoned that a transition to full Vietnamese responsibility for these missions could occur if the South Vietnamese could overcome their fear of ground fire at low spray altitudes, a problem which had ended previous thoughts about "Vietnamizing" the spray mission. The 834th AD suggested that VNAF C-119s could be converted to spray aircraft, at least for mosquito control missions.[1]

At the time the 834th AD study was in the final stages of preparation, Gen. William W. Momyer, commander of the Seventh Air Force, directed the Air Force Advisory Group in South Vietnam to develop a program for having the VNAF take over responsibility for crop destruction, mosquito control, and any increase in herbicide requirements, in this order of priority. The Seventh Air Force staff had suggested this approach, and MACV had indicated its approval of the idea. Momyer was particularly interested in Vietnamizing the spray mission in the near future.[2]

Brig. Gen. Donavon F. Smith, the chief of the Air Force Advisory Group, gave General Momyer a detailed response two months later. The thrust of his reply was negative. General Smith acknowledged that the VNAF could perform the crop destruction and mosquito control missions, but the cost would be high. First of all, a spray system would have to be installed in the C-119 and a training program established in low-level

chemical delivery techniques for this aircraft. Then, one half (eight aircraft) of the VNAF C-119s would have to take up the spray mission, and this would have a severe effect on the total VNAF airlift capability. And, since spray missions required highly skilled crew members, 21 experienced VNAF first pilots would have to leave their airlift duties. Overall VNAF pilot strength at the time was 328 below the authorized level, and the experienced pilots needed could only have been obtained at the expense of other missions. In short, General Smith said that the VNAF could be brought into the spray program, but only at high cost, and he recommended against following this course. These multiple problems killed the proposal to begin Vietnamizing the spray program in 1967, but the idea surfaced again later.[3]

There had been some opposition to the herbicide program on moral and ecological grounds since it began, but the opposition did not reach a level of intensity where it forced the Department of Defense to react publicly until 1967. As early as 1964, the Federation of American Scientists had opposed the use of herbicides in Vietnam on the grounds that the United States was using the conflict there to experiment in biological and chemical warfare.[4] In January 1966, Professor John Edsall of Harvard University led a group of 29 Boston area scientists to protest against the use of herbicides in anticrop warfare. They urged President Lyndon B. Johnson to ban this practice on the part of the U.S. forces and to oppose crop destruction by the South Vietnamese. They claimed that crop destruction was barbarous because it was indiscriminate and constituted an attack on both combatants and noncombatants.[5] A more broadly based petition to President Johnson was personally presented to the President's Science Advisor on February 14, 1967. This petition bore the signatures of more than 5,000 scientists, including 17 Nobel laureates and 129 members of the National Academy of Sciences. It urged Johnson to order an end to the use of antipersonnel and anticrop chemical weapons in Vietnam and argued that breaching the moral restraints against chemical and biological warfare by using these substances would weaken the barriers against the use of more lethal chemical weapons.[6]

In December 1966, the Council of the American Association for the Advancement of Science (AAAS) passed an amended version of a resolution introduced by Professor E. W. Pfeiffer of the University of Montana. The resolution stated that modern science and technology had given man the ability to modify his environment on an unprecedented scale, but that the full impact of such modification, whether for civilian or military purposes, was not known. The resolution went on to call for the establishment of an AAAS committee to study the use of chemical and biological agents to modify the environment, including such use in warfare, and it volunteered

the AAAS cooperation with government agencies in completing such a study.[7]

The AAAS board of directors appointed an ad hoc committee on environmental alteration in March 1967, and in May this committee issued a report calling for studies of the short- and long-term consequences (particularly the latter) of massive uses of pesticides and herbicides, such as the large-scale use of herbicides in the defoliation and crop destruction programs in Vietnam. Shortly thereafter, top officials of the AAAS approached the Department of Defense. In a letter to Secretary McNamara, on September 13, the AAAS president stated that while the military use of herbicides in Vietnam was based on tactical and strategic considerations, these chemicals could have such long-range consequences on both Vietnam and other areas that the subject was deserving of further study ". . . under the highest responsibile political auspices." The letter suggested that the National Academy of Sciences or an independent commission conduct the necessary research.[8]

Dr. John S. Foster, Jr., Director of Defense Research and Engineering, answered the AAAS request one week later. He said that qualified scientists had already judged that the use of herbicides in Vietnam would not have any serious adverse short- or long-term ecological impacts, and that the Department of Defense had confidence in this conclusion. However, he acknowledged that there were uncertainties about the effects, both beneficial and detrimental, of herbicides, and that the DOD had commissioned a non-governmental research institute to conduct an assessment of the present state of scientific knowledge. The National Academy of Sciences–National Research Council (NAS–NRC) would then review this study and make appropriate recommendations.[9]

The nonprofit firm selected to perform this research was the Midwest Research Institute (MRI) of Kansas City, Missouri. MRI completed its rather voluminous report on December 1, 1967. The scientists concluded that the maximum direct ecological consequence of herbicide use was the destruction of existing vegetation; bare soil would not result. Plant succession would be set back, but revegetation would occur and would be similar to that in areas which had been devastated by fire or had been cultivated and then abandoned. The plant-killing effects of the herbicides used in Vietnam would not last for long; accumulations in the soil would cause no problem. The MRI researchers said that the food chain of animal life would be altered by herbicide use, but the long-term effects of this alteration were unknown. On the question of lethal toxicity to human or animals, the researchers found that, except for cacodylic acid, this was unlikely and should not be a matter of great concern. They recommended more research on cacodylic acid, the main component of herbicide blue, and on the effects of 2,4-D and 2,4,5-T on the water quality of streams and lakes. MRI also said that not enough was known about the effects of killing vegetation over large areas—including possible localized climatic changes or drainage

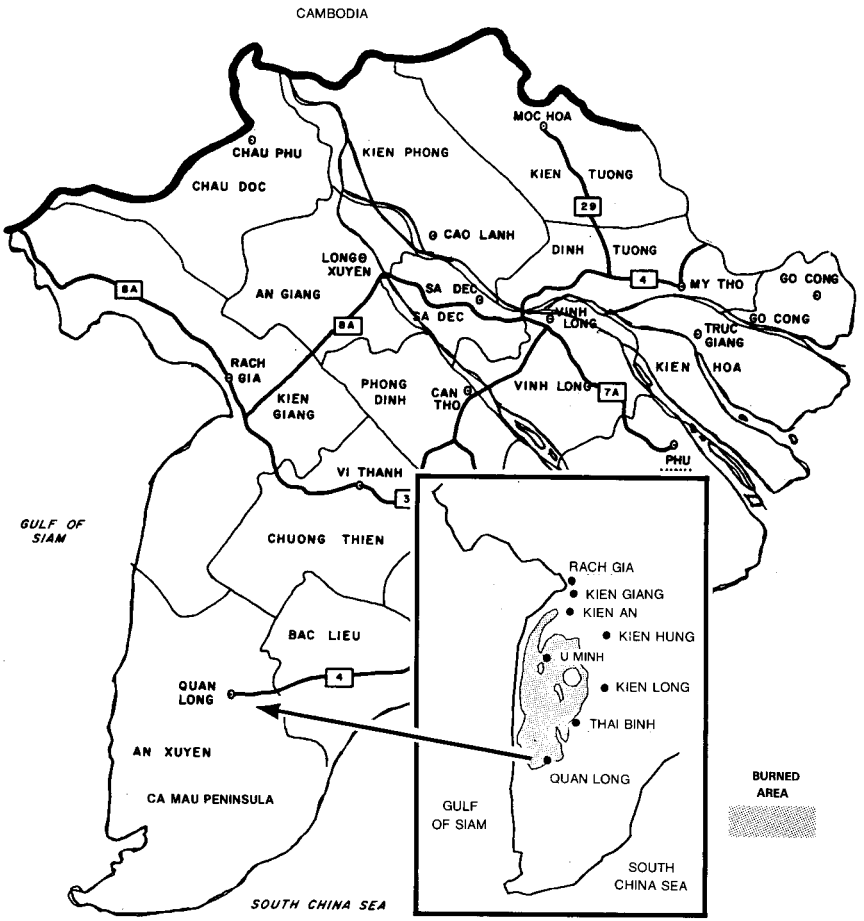
pattern changes which might result in increased laterization (iron-hardpan formation). In spite of unresolved questions, MRI concluded that there was no cause for great alarm about the ecological effects of the extensive use of herbicides in South Vietham but that further research was needed.[10]

The MRI study had a varied reception. A National Academy of Sciences assessment panel concluded that although MRI had done a creditable job of collecting the existing scientific knowledge about herbicides, there simply was not much information to be found concerning the ecological effects of repeated or heavy herbicide use. The NAS president called for more research on this question. The American press gave the MRI study inconclusive reviews. While *Time* magazine said that there was ". . . no evidence that there will be long-range damage to plant or animal life in South Vietnam,"[11] *Newsweek* concluded that a complete evaluation of the effects of herbicides in Vietnam would have to wait for the end of hostilities in the treated areas so that scientists could perform the necessary studies.[12] The unresolved ecological questions about herbicides had by this time been raised in the public's mind, and they would continue to be an important factor throughout the remaining time of Ranch Hand's existence.[13]

In early 1968 a large fire in the mangrove forests of the Ca Mau Peninsula seriously affected Viet Cong activities in that region. Defoliation played a minor role in this unplanned conflagration, proving once more that climate and local weather conditions have far more effect on sustaining and spreading forest fires than human intervention. The area involved in the fire was the U Minh Forest, a mangrove area about 140 miles southwest of Saigon which had been a Viet Cong hideout for many years.

The first quarter of 1968 had been the driest in a quarter century in regions bordering the Gulf of Thailand, and forest fires were severe that year in Malaysia, Thailand, Cambodia, and Vietnam. The exact origin of the U Minh fire is not known, but reports reaching MACV in Saigon indicated that it started on or about March 10, 1968, perhaps when a group of angry South Vietnamese fishermen who had been barred from the area by the Viet Cong started several fires in retaliation. Thirty-knot winds, the very dry vegetation in the area, and the burning and explosion of a large ammunition dump shortly after the fire began helped it spread rapidly. Four days later, white phosphorus ammunition started another fire some distance away, and on the 20th, a third fire started from unknown causes. Strong winds and dry conditions again caused the fires to advance. Fire spread over a large area during the latter part of March and early April. Attempts by the Viet Cong to construct firebreaks to contain the conflagration were unsuccessful.

AREA BURNED IN U MINH FOREST FIRES
MARCH-APRIL, 1968



Seeing the benefits from such a vast fire, Air Force O-1s used white phosphorus marking rockets and grenades to establish other points of burning to help the fire spread. Forward air controllers directed fighters dropping napalm and bombs. Observers reported hundreds of secondary explosions of ammunition and petroleum during the second and third weeks of April, and one estimated that, for a time, secondary explosions occurred at the rate of one every twenty minutes. Gunfire from ships off the coast poured thousands of rounds into the area, accounting for hundreds of destroyed structures and numerous secondary explosions, all of which hampered Viet Cong efforts to move supplies out of the area or to stop the fire from spreading.

By the time the fire ended on April 29, 1968, it had burned for 50 days, destroying 75% to 85% of the forest in an area 48 miles long and 24 miles wide. When the seasonal rains came in May and June, the water floated the trees which had tipped over because their roots had burned, into piles up to four miles long, one-half mile wide, and 10–15 trees deep. Estimated Viet Cong losses due to the fire and associated military activity were 100 to 200 killed plus extensive destruction of ammunition supplies.

In addition to the dry weather, another factor crucial to sustaining the fire was the region's peat soil which would itself burn and allow the fire to smolder overnight and flare up when the winds increased the next day. Areas which had been treated with defoliants burned better than untreated areas, and, in some cases, ground fires actually stopped burning when they reached the outer boundary of a defoliated strip. Still, Ranch Hand could only take a minor portion of the credit because of the crucial roles played by weather and soil type.[14]

Like the other components of the U.S. military machine in Southeast Asia, Ranch Hand began the year 1968 not knowing that the Viet Cong were about to launch their largest combined offensive of the war. This offensive, among its many other effects, temporarily disrupted the herbicide program. During the first 29 days of January, the 12th ACS set a new monthly record of 589 on-target spray sorties. Then, according to plan, Ranch Hand suspended operations for the South Vietnamese Tet holiday. During the morning of January 31, Bien Hoa received an intense rocket and ground attack, and the 12th ACS was unable to fly either that day or the next. During the six days beginning on February 2, Ranch Hand used its planes alternately for defoliation and emergency airlift operations. With the spray tanks still installed, the unit flew 18 airlift sorties which carried 21,000 pounds of cargo, 172 passengers, and 203 prisoners of war. Most of these

first airlift sorties consisted of emergency "mail runs" between Bien Hoa and Tan Son Nhut, and the squadron received high praise for this important volunteer effort.

Early on the morning of February 8, Seventh Air Force directed the 12th ACS to remove the spray equipment from its aircraft and begin a full-time airlift operation. Since 12 aircraft were already loaded with herbicide for that day's missions, these UC-123s flew their planned spray sorties, the last which would occur for more than a month. By mid-morning on February 8, maintenance personnel had begun the removal of spray gear from the Ranch Hand planes, and at 0630 on February 9, the first reconfigured UC-123 took off on an airlift sortie. In only 23 hours, sixteen Ranch Hand aircraft had been switched to a transport role. The unit flew no herbicide sorties through March 15, when maintenance personnel received instructions to begin switching the planes back to a spray configuration. Mechanics readied eight UC-123s to fly herbicide missions in slightly more than 12 hours. By the evening of March 19, Ranch Hand planes had been reconverted for their original mission, and the unit flew a full schedule of spray flights on March 20, 1968. During the Tet Offensive, the 12th ACS had flown 2,866 airlift sorties.

Bien Hoa, the home base of the 12th ACS, suffered its greatest casualties of the Tet Offensive during a 122-mm rocket attack on the morning of February 28. The attack severely affected Ranch Hand operations, causing all scheduled flights for that day to be cancelled. Rockets completely destroyed four buildings housing Ranch Hand officers, heavily damaged another, and inflicted light damage on four more. Thirty-three of the unit's officers lost all of their possessions other than the clothes they were wearing, while 27 others had some loss or damage. Only one officer, however, had to be hospitalized, and he only had minor burns and bruises. After losing one day of cargo missions, the unit resumed a full schedule of flights on February 29, 1968.[15]

The Combined Campaign Plan devised by South Vietnamese and American commanders for 1968 stated that defoliation operations that year would concentrate on friendly lines of communications, North Vietnamese and Viet Cong base areas which were targets of specific military operations, and a buffer zone three to five kilometers wide along South Vietnam's western border which would hopefully aid in slowing infiltration. This changed the pattern of previous years when crop destruction and clearing vegetation from large base areas had been given the highest priority. The reordered priorities for 1968 were due to a shift in ground operations to I Corps and the DMZ, along with the fact that the clearing of War Zones C and D which

Contrast in sprayed areas along river banks: top for defoliation using "Agent Orange"; bottom for crop destruction along left bank of the river using "Agent Blue."

had absorbed most of the 1967 sorties was finished. Political considerations were also a factor since Ranch Hand had sprayed so much herbicide over the relatively densely populated III Corps area—operations in 1968 over less populous areas such as I and II Corps were expected to have fewer political ramifications. Another departure from the pattern set in previous years was that Ranch Hand had flown no crop destruction missions at all between January and May. This change resulted from a backlog of high-priority defoliation targets and from the weather which, being unusually dry, caused fewer lucrative crop targets to appear. In June, crop destruction flights began again, and Ranch Hand sprayed about 8,600 acres that month.[16]

On June 26, 1968, Ranch Hand began using Nha Trang as a point for loading fuel and herbicides. The unit's UC-123s would take off from Bien Hoa on their first mission of the day and, after spraying, land at Nha Trang. With their fuel and herbicide replenished, they would then spray another target before returning to Bien Hoa. This procedure made it much easier to fly spray missions in the II Corps area.[17]

A fifth Ranch Hand aircraft crashed after encountering heavy ground fire during a spray mission over An Xuyen Province on May 24, 1968. Just after a flight of six UC-123s had completed their spray run, smoke was observed pouring from the left engine of the number two aircraft. Trailing smoke, the plane entered a steep descending spiral to the left and struck the water about 1.5 km off the Vietnamese coast. All three members of the crew perished.[18]

In May 1968, the 12th ACS received its first UC-123K, a converted UC-123B. By June 30, the squadron had six of this new type of aircraft. All Ranch Hand UC-123s were scheduled to undergo conversion by March 1969. The K-model modification consisted of the installation of two J-85-17 jet engines to supplement the two radial piston engines, a modulated anti-skid braking system, and a combination stall warning and angle of attack indicator. The additional thrust provided by the jets greatly increased the aircraft's ability to tolerate the loss of an engine, while the extra airspeed and rate of climb reduced vulnerability to ground fire by enabling the spray planes to spend less time at low altitude and increased safety margins during operations over mountainous terrain. To enable the spray delivery system to keep pace with the higher flying speeds, Ranch Hand UC-123Ks also received a larger spray pump and a flow meter to regulate the deposition rate at a constant three gallons per acre regardless of the plane's speed.[19]

In January 1968, Ambassador Ellsworth Bunker (who had replaced Lodge the previous year) ordered a full policy review of the herbicide program. A committee consisting of senior representatives from the Embassy,

MACV, the U.S. Agency for International Development (USAID) and the Joint U.S. Public Affairs Office (JUSPAO) prepared a report for Bunker during the period March 1–May 1, 1968. The committee consulted a wide range of documents and interviewed many American officials—military and civilian—in South Vietnam. A group of four consulting scientists added their specialized knowledge. Three of the scientists came from the United States especially to help the committee with its work.

Their report found, as had preceding evaluations, that the herbicide program was successful from a military viewpoint. The committee also noted that the program had the potential for causing seriously adverse economic and social effects. They credited the elaborate policy and operational controls under which herbicides had been used since the beginning with preventing serious problems from developing. Nonetheless, they acknowledged that herbicides had brought with them economic and psychological costs, and they argued that at least some of these negative by-products of the program could be reduced or eliminated. On balance, the committee found that the benefits of herbicides in Vietnam outweighed their costs and associated problems, and they favored the continuation of the program, with some refinements.[20]

This report contained a very clear statement of the military rationale behind the defoliation program:

> A key element in US military strategy in the Vietnam war has been the utilization of the unprecedented firepower that modern science, industry and logistics have made possible. US forces are engaging the enemy with much higher rates of return fire than in any previous war. For example, US 105-mm howitzers fired an average of 24 rounds per weapon per day during World War II. In Vietnam, the average daily rate is 40 rounds. The US is currently spending nearly $4 billion per year for ammunition. On the ground and from the air, US commanders are substituting firepower for manpower. As a result, an undeterminable but large number of American and Allied lives have been saved.
>
> Much of South Vietnam, however, is covered with dense forests, jungle and mangrove. Utilization of this natural concealment has afforded the enemy great tactical and logistical advantages *vis-a-vis* Allied forces. A paramount military problem from the outset, therefore, has been the difficulty of locating the enemy, his bases, and his LOCs. Without information about enemy dispositions, our forces cannot exploit their advantage of superior firepower.
>
> Defoliation by chemical herbicides is the principal way by which Allied forces obtain visible observation of enemy forces, facilities, ambush sites, infiltration routes and other enemy-used LOCs. It is also employed to enhance security around Allied base camps, airfields, ammunition dumps, ports, and along LOCs by providing defensive fields of fire. . .[21]

The authors clearly recognized how herbicides had contributed to the policy of substituting readily available firepower for manpower, a much more precious commodity to American political and military leaders.

The Herbicide Policy Review Committee, however, also pointed out what they considered to be substantial economic costs of the defoliation program. They cited the fact that the spray had killed or damaged large

stands of merchantable timber in War Zones C and D. Because the forests of Vietnam were among the country's most valuable renewable natural resources and a major source of employment, they were concerned that repeated applications of herbicides to these forests might retard their regeneration. Another economic cost cited was unintentional damage to crops, particularly in the II Corps area. Their investigations found that claims for crop damage from herbicides stemmed from a variety of factors, including plant disease, spray drift, defective equipment on the Ranch Hand planes, emergency herbicide dumps, inadequate care of crops by farmers, and errors in targeting and navigation. They could not specify how much of the actual damage was due to defoliation operations and how much should be attributed to other causes. Allegations of damage to rubber trees which had surfaced in a significant way in 1967 were found to be exaggerated. Herbicides had been responsible for rubber tree damage in only seven of the 16 sites examined, and most of the trees damaged by herbicides were expected to recover. Many of the allegedly damaged trees were found to be suffering from disease and poor maintenance by growers.[22]

As had others, this committee also said that the ecological consequences of herbicides were not serious. The only significant ecological effects were the destruction of large stands of mangrove, which were expected to regenerate in 20 years, and damage to the tropical forests of War Zones C and D. Attached to the report were three appendices which examined herbicide toxicity and persistence in water and soil and the potential hazards from herbicide vapors.[23]

The crop destruction program received some additional criticism. The review committee noted that crop destruction, which constituted 15% of the overall herbicide effort in 1967, had destroyed only about 1.75% of the South Vietnamese rice crop. Although there was some evidence that crop destruction had contributed to enemy logistics difficulties, the committee stated that the civilian population of the target areas bore the main burden. They called for further efforts to reduce the harm done by crop destruction to innocent civilians.

Another criticism concerned the length of time it took to process requests for specific herbicide projects. The committee called for the delegation of approval authority for helicopter defoliation operations to corps commanders and recommended area clearances for crop destruction operations so that targets of opportunity could be struck. They also recommended greater efforts to provide Saigon officials with the necessary information to manage and monitor the herbicide program effectively.[24]

Other important recommendations concerned the psychological warfare and compensation efforts. The committee asserted that " . . . the use of herbicides is definitely and universally attributed to the U.S. The attempt to identify the GVN with the program has failed completely. . . "[25] They said that even when Vietnamese personnel sprayed herbicide using truck-mounted sprayers, the local people attributed the spraying to the United

States. The committee said that the South Vietnamese government had not provided the necessary psychological support for the program, and that U.S. officials should assume this responsibility if they could not persuade the South Vietnamese to improve. Linked to this was the inadequate system for settling claims for defoliation damage. It did not fully compensate people for damage caused, and it operated only in government-controlled areas while the most damage probably occurred outside the area of Saigon's control where most of the herbicide targets were located. Corrupt local officials often kept much of the compensation payments for themselves through a system of "fees" for cashing payment checks, and other such methods. Filing a claim for herbicide damage was an administrative nightmare, especially for a poor peasant. Seven or more supporting documents were required with eight copies of each. The assessment committee called for a simplification of procedures and more effort by MACV advisors to keep track of the claims program.[26]

Ambassador Bunker formally approved the herbicide policy review report on August 28. A few weeks later, he met with South Vietnam's President Thieu and gave him a copy of the report along with an oral summary of its findings and recommendations. Thieu stated that he felt that herbicides had had some military value earlier in the war when they had been more widely used but future use should be limited and highly selective. With Vietnamese, American, and other allied forces now stronger and more effective, he felt that herbicides should be sprayed only along infiltration routes and in uninhabited areas. It was no longer wise, Thieu said, to use them in populated and cultivated areas as the communists had been able to turn herbicides into a propaganda issue in Vietnam and in other countries.[27]

At about the same time that the Embassy was promulgating its herbicide policy review, MACV completed two evaluations. In August 1968, MACV reported to CINCPAC that ". . . all field commanders, without exception, state that herbicide operations have been extremely effective in assisting the Allied combat effort." Two months later, the results of another military evaluation ordered by MACV again supported the continuation of the herbicide program. In spite of these positive reports, however, the future of herbicides was clouded by ecological questions, President Thieu's attitude, and the fact that the disengagement of the United States from Southeast Asia was about to begin.[28]

During 1968, the 12th Special Operations Squadron (SOS)* struggled with the same poor working conditions at Bien Hoa that had existed since

* Air Commando units were redesignated Special Operations units on August 1, 1968.

the unit first moved from Tan Son Nhut in December 1966. The squadron operations and maintenance sections were both housed in a Vietnamese Air Force hangar which they shared with a civilian firm's aircraft maintenance personnel. Power outages were frequent and sometimes lasted for days at a time until the middle of August 1968 when a mobile generator arrived and partially relieved the situation. The building housing Ranch Hand's offices provided only minimal protection from the tropical dust and heat and the swarms of flies. Noise from aircraft opertions and heavy construction nearby was also a problem. Toilet facilities were described as "deplorable." This situation improved somewhat on December 28, 1968, when Ranch Hand operations moved to a new location nearer the center of the base, although a long ride from the operations offices to the aircraft parking area made the situation still less than ideal.[29]

In mid-1968, Ranch Hand began using a turn-around facility at Phu Cat to supplement the one at Nha Trang. Being able to obtain fuel and herbicides at these two additional bases enabled the Ranch Hand planes to fly more missions in the northern areas of II Corps without having to return to the main base at Bien Hoa.[30] In the south, Ranch Hand temporarily suspended operations in part of the Delta region of IV Corps after July 2. On that date a six-plane formation was the target of intense .30- and .50-caliber ground fire for the entire four minutes of its target run. All six aircraft received some damage. F-100 fighters accompanying the flight had employed heavy suppression tactics before the spray run, but entrenched Viet Cong gunners were still able to damage the spray planes. No crewmembers received injuries and all of the UC-123s returned to base safely, but Seventh Air Force ordered a temporary halt to further spray missions in this part of the Delta. The Da Nang operation, meanwhile, by August 1968, had added six aircraft. Eleven were now available to take advantage of the better weather existing in I Corps at that time.[31]

During July 1968, Ranch Hand developed more fully the tactic called "heavy suppression" to counter increased ground fire over heavily defended targets. When Ranch Hand flew over such targets, at least four, and sometimes as many as twelve, fighters accompanied the spray planes. On the day prior to a mission, the pilots who would be leading the Ranch Hand planes met with the fighter pilots to decide on specific tactics. When heavy suppression was involved, fighters would strike strong points in the target area with 500- or 750-pound bombs two or three minutes before the UC-123s began their spray run. Timing on this prestrike was critical, because if the fighters dropped their bombs too soon, the enemy forces would be alerted and would have time to react. On the other hand, if the bombing took place too late, the Ranch Hand aircraft might be endangered by flying fragments and debris thrown into the air by the bombs. When the spray run began, fighters would fly slightly ahead of and parallel to the spray planes and drop antipersonnel CBUs to force any gunners on the ground to stay under cover until the spray formation had passed. Some fighters retained part of their

ordnance load to use in assisting a rescue in the event any plane crashed. If no rescue was needed, the fighters used the extra ordnance to hit any sources of ground fire which had been noticed. The heavy suppression tactic, designed to reduce ground fire rather than to destroy enemy fortifications, was able to cut considerably the number of hits Ranch Hand planes received over heavily defended targets.[32]

On September 29, Seventh Air Force directed the 12th Special Operations Squadron to remove the spray equipment from eight UC-123s and reconfigure them for airlift operations. The 12th SOS immediately recalled six planes and their crews from Da Nang to assist in this effort. Prior to their remodification to the spray configuration on November 15, Ranch Hand UC-123s hauled more than 4,300 tons of cargo. On December 16 and 24, 1968, two spray planes were again requisitioned for airlift missions.[33]

Even with such breaks for airlift duties most Ranch Hand missions were routine, with little to distinguish one from another. Once in a while, however, the crews were called on to handle unusual situations such as that one encountered by Lt. Col. Winthrop W. Wildman and his UC-123K crew on December 13, 1968. Wildman's plane, leading a six-aircraft formation against a target some 15 miles north of Bien Hoa, received intense automatic weapons fire as it completed its spray run. As he advanced the power on the jet engines to 100% to climb back to cruising altitude, Wildman's plane suddenly began to roll to the left. Alerting his crew for a possible crash landing, Wildman regained control of the aircraft by applying full right aileron control and full left rudder. He leveled off at an altitude of 1,200 feet. His instructor pilot, Maj. Jack G. Womack, reduced the right jet engine to idle thrust while leaving the left jet at full power. By applying this assymetrical thrust and holding the flight controls at full deflection, the wings could be kept level.

The flight engineer, SSgt. Richard L. Gage, removed his body armor and left the protection of his armored box, even though the plane was still low enough to be threatened by ground fire, so that he could check the condition of the aircraft and inform the pilots. Gage discovered that the plane had been hit many times, that holes were visible in the wings, flaps, and engine nacelles and, what was worse, that the left aileron was in a 45-degree up position with its control cables loose. In spite of this tenuous situation, both pilots felt that they had enough control over the aircraft to attempt an emergency landing. The navigator, Lt. Col. Lawrence L. Waitt, provided a heading to Bien Hoa; the crew prepared for a possible crash landing; and Gage stood by to lower the landing gear manually.

Wildman decided on a straight-in approach with no flaps, and he used an above normal airspeed to increase the effectiveness of his controls. He maintained his direction primarily by using the rudder and differential power, since he needed full right aileron control to hold the wings level. Immediately after touchdown, as the main hydraulic system pressure dropped to zero, the odor of hydraulic fluid filled the air. Normal steering on the

runway by the use of brakes and the nose wheel was ineffective, and the aircraft began to veer to the left. Wildman applied the emergency air brakes, and, although no use of reverse thrust had been planned, Womack reversed the propeller on the right engine to keep the spray plane from leaving the pavement. The aircraft finally came to a safe stop on the left side of the runway.

An inspection afterwards discovered that 18 bullets from one or more .30-caliber automatic weapons had hit the plane. The most critical damage had been the severing of the left aileron control cable and the hydraulic line which controlled the nose wheel steering. In addition, the left main tire had been punctured, causing it to go flat on landing and pull the aircraft to the left side of the runway. Quick and effective action by the Ranch Hand crew had saved their lives and their aircraft.[34]

Between January and March 1969, the 366th Tactical Fighter Wing (TFW) based at Da Nang flew nine missions to test the possibility of using F-4 aircraft as high-speed spray planes over targets where the threat from ground fire was high. Two standard external fuel tanks on each F-4 were modified to carry 278 gallons of herbicide each. Normally the tanks could each carry 370 gallons of jet fuel, but in order to fill their nose and tail sections, the liquid had to be pumped under pressure, and this caused the herbicide to foam. Accordingly, only the center section was filled. An F-4 flew a test mission over the runway at Da Nang on January 17, 1969 spraying colored water with good results. Between January 20 and March 29, the 366th TFW flew eight more herbicide missions of three F-4s each over spray targets in South Vietnam and Laos. Delivery was at 500 knots from 100 to 200 feet above the jungle canopy along a route marked by a forward air controller. The three-ship formation flew with the two wingmen positioned ten degrees to the rear and about three plane widths away from the leader. This generated a spray pattern some 300 feet wide with a deposition rate of 4.3 gallons per acre.

The F-4 experienced some problems when used as a spray aircraft. On three of the missions, a tank either collapsed or failed, and once a failing tank damaged the underside of the plane's wing and aileron. Speculation centered on a venturi suction effect around the tank's spray nozzle as the cause of these failures, but this was never determined. On the last F-4 herbicide mission, the number three aircraft in the formation crashed during its spray run. Another spray tank failure was immediately suspected, but the aircraft commander later stated that he was sure ground fire had hit him just before he lost control of his F-4. Nevertheless, the crash on March 29, 1969, ended the use of the F-4 as a spray plane.[35]

In early 1969, Seventh Air Force conducted an in-depth analysis of the spray program's preceding two years. This report, although concentrating

somewhat more on procedures and tactics than had some of its predecessors, also found that the use of herbicides in South Vietnam was militarily beneficial. The Seventh Air Force analysts concluded that the resources allocated to the mission were being used effectively and that the program was under effective control. However, they noted that the "less clearly productive crop destruction program" was being trimmed to keep the detrimental effects of herbicide use to a minimum. This was reflected in the proportion of sorties allocated to crop destruction in 1968 and 1969—only about 5%, as compared to 12.5% in 1966 and 1967, and 29.7% in 1965. Another observation was that the processing time for herbicide requests was growing shorter with the implementation of changes recommended by the 1968 Herbicide Policy Review Committee. The time from the province chief's request to the first Ranch Hand flight was down to two and one half months.[36]

Because of an expected enemy offensive in late February 1969, Ranch Hand pilots flew all operational spray planes from Bien Hoa to a temporary location at Phan Rang on the 22d. This movement took place none too soon. On February 23, the Viet Cong launched a country-wide offensive. Flight and maintenance crews, however, had gone with the Ranch Hand planes and the unit was able to fly its spray missions as scheduled. Before returning permanently to Bien Hoa on March 3, the Ranch Hand UC-123s followed the pattern of leaving Phan Rang loaded with fuel and herbicide in the morning; flying their first scheduled mission; landing at Bien Hoa to pick up more fuel and herbicide; flying the second spray missions of the day; returning to Bien Hoa to pick up fuel and herbicide for the next day's missions; and finally shuttling back to Phan Rang where the UC-123s remained overnight.[37]

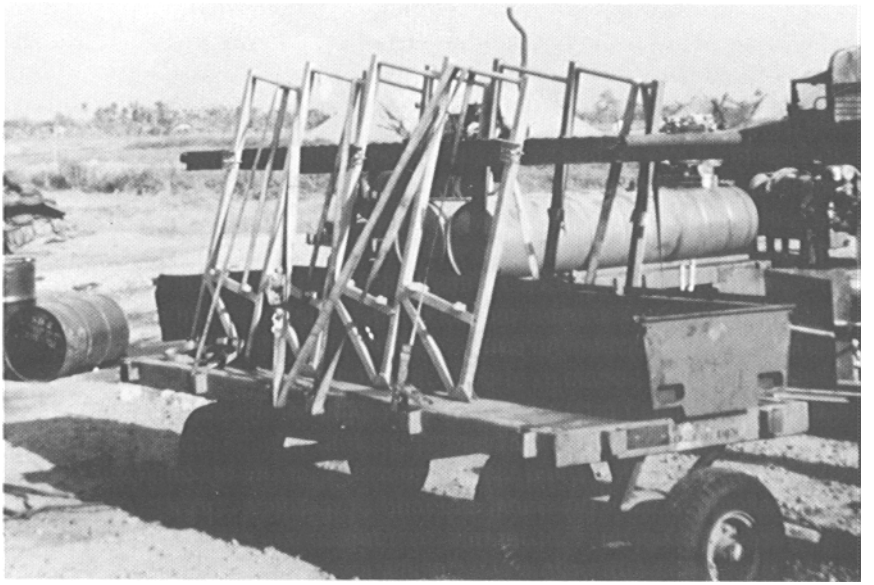
By April 1969, all Ranch Hand planes had been converted to the jet-equipped UC-123K version. The extra power provided by the jets allowed Ranch Hand to fly some experimental spray runs at an airpseed of 180 knots, about 50 knots greater than the usual speed. This higher speed made the spray planes harder for gunners on the ground to hit, but it reduced the time available for the pilots to make flight path adjustments necessitated by varying terrain and target shapes.

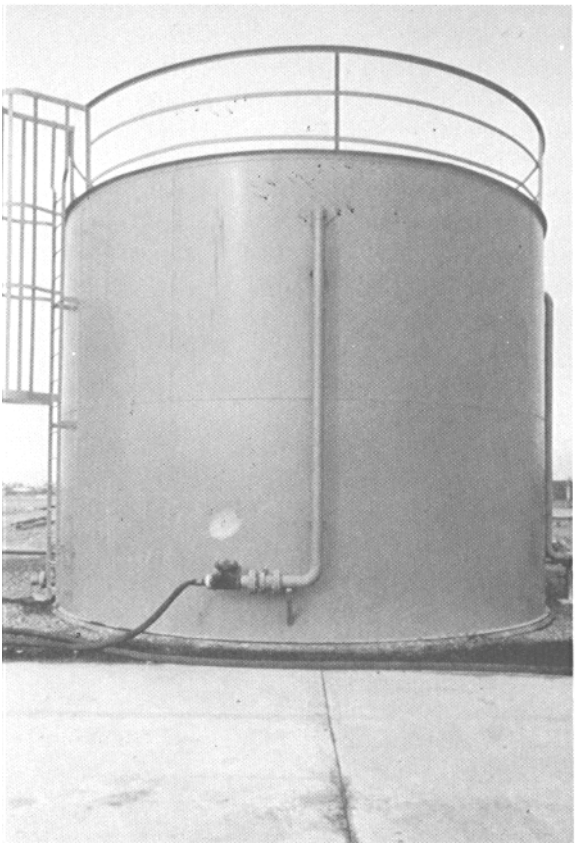
Ground fire was still a serious problem in early and mid-1969, as a mission on April 7 illustrated. On that date, a formation of seven Ranch Hand aircraft had planned to make three separate passes over their targets in the Delta. On the first pass, all but one were hit by .30- and .50-caliber machine gun fire. Two of the UC-123Ks lost an engine and proceeded at once to Bien Hoa. The five remaining aircraft received ground fire on the second pass, and the last plane in the formation lost effective aileron control as bullets penetrated its left wing and control surfaces. Like the crew of the UC-123 the previous December, the crew maintained limited directional control by using differential power settings on its left and right engines. After flying to the airstrip at Ben Tre for an emergency landing, the crew discovered a

C-130 on the dirt runway which could not move clear in time for the damaged Ranch Hand plane to land. Unable to climb away from the field and return for another landing attempt, the crew chose to set the aircraft down in rice paddies 200 yards to the side of the runway. The crew escaped injury, but the UC-123K received extensive damage. In response to this incident, Seventh Air Force again restricted Ranch Hand's activities in IV Corps.

Farther north, four Ranch Hand planes suffered severe damage from .30- and .50-caliber automatic weapons near Hoi An on June 22, 1969. As their flight reached the midpoint of its target, the number four aircraft lost an engine to ground fire. Almost immediately the flight leaders's plane lost its windscreen which shattered, injuring all three of the cockpit occupants. Together, the four planes were hit 62 times causing damage to engines, nacelle fuel tanks, landing gears, hydraulic systems, cockpits, and cargo compartments. This ground fire damage occurred despite a target prestrike which included forty 1,000-pound bombs and 1,500 rounds of heavy artillery. In addition, eight fighters flew alongside the spray planes dropping cluster bombs. Although previous defoliation missions over this target on April 24 and May 22 may have established a pattern of approximately thirty days between missions, allowing the enemy to increase defenses, this level of opposition, especially after heavy suppression tactics, was intolerable.[38]

On July 19, 1969, a meeting to discuss spray tactics and procedures in the I Corps area took place. Among the participants were the 12th SOS commander, the Detachment 1, 12th SOS commander (Da Nang operating location), and the commander of the 315th SOW, the 12th SOS's parent unit. They decided that, in the future, defoliation scheduling would allow a face-to-face briefing between the forward air controller and fighter escort leader before each mission. In order to achieve greater security and surprise, all aircraft would keep radio transmissions to a minimum; several spray targets would be authorized each day with the one to be sprayed chosen at random; and the aircraft would orbit over a point somewhat removed from the target until all elements of the herbicide strike force were in place. The Ranch Hand planes would not return for multiple passes over a target where ground fire had been noted on the first pass. To deter gunners on the ground from firing at the spray aircraft, A-1 fighters would provide flank protection and direct escort while armed helicopters would place themselves over areas of known or suspected small arms fire. The helicopters and A-1s would be able to determine more readily the source of ground fire than faster jets. F-4s, meanwhile, would stay above the spray formation and be ready for any required poststrike. Ranch Hand also adopted the policy of not spraying a target unless fighters were cleared to return ground fire immediately without waiting for the forward air controller to give his approval. These new tactics had a significant effect in reducing ground-fire hits. The 12th SOS had received 147 in July 1969; the number declined to 70 in August, and decreased further, to 58, in September. By December, the total had shrunk to only 13 hits. The number of sorties at that time, however, had also declined—to about 75% of the July figure.[39]





Top: drain tank for defoliant drums, Bien Hoa, 1968; bottom: large "Agent Orange" storage tank, Bien Hoa, 1969.

Even as the sorties decreased, ecological problems continued to surface. Unintended damage from storage drums and accidental leakage was remedied, but emergency dumps remained a problem. In the early part of 1969, residents of Da Nang noticed that large numbers of shade trees were dead or dying and that garden plots had also suffered damage, probably from herbicides. Investigation eliminated spray drift as a cause, and suspicion centered on "empty" herbicide drums which individuals had moved and stored throughout the city. Unfortunately, when the herbicide was drained from these drums, as much as two or three gallons remained inside. The combination of herbicide orange's oily base and the small openings in the drums made it difficult to remove the residue. The used herbicide drums had been widely distributed from the two principal Ranch Hand loading points, Da Nang and Bien Hoa, and from other locations. Vaporization of the herbicide as people moved and stored the drums had caused the damage to vegetation. The local people had also employed the drums as containers for water, diesel fuel, and gasoline. The burning of herbicide-contaminated fuel in motorcycles and other vehicles added to the problem. The situation was remedied by punching holes in the tops and bottoms of the used herbicide drums eliminating any further storage use.[40]

Another problem contributing to unintended damage to crops and other vegetation was the small amount of herbicide which occasionally leaked from the Ranch Hand planes' nozzles after the pressure was reduced at the end of the spray run. In spite of rigorous maintenance, trapped sediment or deteriorated nozzle diaphragms sometimes allowed the residual herbicide in the spray booms to dribble out at high altitude causing widespread injury to sensitive plants. To correct this problem, the Hayes Company, engineers for the spray system, incorporated reverse valves in later modifications to the A/A45Y-1 spray equipment to create suction at the nozzles after the pilot cut off the spray.[41]

An additional source of accidental herbicide damage was emergency dumps of herbicide which the Ranch Hand planes infrequently made upon experiencing a loss of power. In the period December 1968 through August 1969, only five dumps had occurred, and one of these took place over the ocean. The other four had been within a radius of 20 to 25 km of Bien Hoa at altitudes between 2,000 and 3,500 feet. One dump caused damage to trees and crops over a one-kilometer square area, another covered an area one wide and two to three kilometers long. These dumps, when they occurred, caused severe damage in a relatively limited area. Those in the immediate vicinity of Bien Hoa may have accounted for some of the damage to shade trees east of the city.[42]

IX. Ranch Hand Ends Its Work

The publication of the MRI report on the ecological effects of herbicides in late 1967 did not dampen the concern of scientists. The Board of Directors of the American Association for the Advancement of Science reviewed the MRI report along with the comments of the National Academy of Sciences and issued a statement of its own in July 1968. The AAAS board agreed that many questions about the ecological effects of herbicides remained unanswered and recommended an international field study under the sponsorship of the United Nations to analyze the long-range effects of the herbicides and to determine what steps should be taken to protect the future of Vietnam's ecology. They were especially concerned about arsenical herbicides, such as agent blue, and urged that the use of this type of herbicide be stopped until more was known about the ultimate fate of the arsenic in these chemicals once it was released on the land. They also called for the declassification of data revealing the dates and locations of herbicide missions and identifying the chemicals applied in each instance to help scientists in their studies. Supplementary statements by various groups of scientists ranged from calling for an end to the entire herbicide program to arguing that using 2,4-D and 2,4,5-T on forests was a military device for saving lives which caused a level of harm to the environment which was unprecedentedly low, presumably compared to alternatives such as high explosives or napalm.[1]

In July, to further its call for a United Nations sponsored investigation, the AAAS sent letters to that international body and to the U.S. Departments of State and Defense. The U.N. response was noncommittal, stating only that the Secretary General was paying very close attention to the matter of chemical and bacteriological weapons. The State Department's answer noted that there were differences of opinion even among the members of the AAAS concerning herbicides, but it acknowledged that ultimate effects could only be determined by a long term study in Vietnam. State favored such a study and promised cooperation, but it also noted that, at present, research work in combat areas would be difficult. The Defense Department's reply to the AAAS, signed by Dr. John S. Foster, Jr., the Director of Defense Research and Engineering, agreed with the idea of conducting a systematic scientific investigation of long-range herbicide effects in Vietnam, but only after the return of peaceful conditions to the country had made such studies feasible. Foster said that his department continued to be confident that herbicides would not have a long-term negative impact on South Vietnam's people or interests. On the subject of herbicides containing arsenic, Foster said that Malaysian rubber and oil palm plantations had

employed them for more than 20 years with no adverse effects at rates five to six times greater than those used in South Vietnam. This AAAS attempt in 1968 to start an extensive scientific investigation failed, but it was by no means the last such effort.[2]

Shortly after this exchange of letters, on September 18, 1968, the work of the Herbicide Policy Review Committee, which Ambassador Bunker had appointed, was reported to the press in Saigon. Three scientific papers accompanied the press release describing the committee's report, one by Dr. F. H. Tschirley and the other two by Dr. C. E. Minarik and Dr. Robert A. Darrow. Tschirley had made brief air and ground surveys of both mangrove and semideciduous forests. He based his conclusions on his prior experience plus these limited observations. There was no great effect, he said, on higher plants and animals from the increased wind speed and ground temperature in defoliated areas. Some lower life forms dependent on specific microclimatic niches might suffer temporary effects. Tschirley asserted that herbicide use would not significantly hasten the laterization of soil in Vietnam. Only about 30% of the soil was of the type susceptible to laterization, and defoliation did not produce bare dirt which might increase the evaporation rate of ground water, possibly hastening the precipitation of ferrous iron and its oxidization into the insoluble ferric form. Tschirley said that twenty years was a conservative estimate of the time it would take the mangrove areas to return to their original condition. Because of the increasing fish catches near sprayed mangrove forests, herbicides had probably not seriously affected the aquatic food chain. On the other hand, bird and invertebrate populations had probably decreased in mangrove areas. In semideciduous forests, Tschirley found that single sprayings had had no great or lasting effects, but that repeated applications of herbicide would probably have a far greater impact, with the most serious danger being posed by the invasion of bamboo.[3]

Minarik and Darrow examined the toxicity of the herbicides in use in Vietnam. They quoted the conclusions of the MRI report concerning 2,4-D and 2,4,5-T that the toxicity of these two chemicals was very low, although there might be a problem with fish and fish foods under some conditions. Additionally, they presented data not available to the MRI researchers which showed very little fish toxicity from the dosage of agent orange being used in Vietnam. On the potential danger from agents white and blue, they concluded that neither of these herbicide formulations posed a safety hazard as they were being used in Vietnam.[4]

These same two scientists examined the persistence of herbicides in soil and water and, again, they found no cause for concern. Because of microbe action, the butyl esters of 2,4-D and 2,4,5-T used in orange decomposed rapidly in the soil and disappeared within one to three months at the application rates used in Vietnam. The picloram in white was somewhat more persistent because microbes did not act on it as quickly. Tests in Puerto Rico using direct applications of picloram to soil at rates four to six times greater

than those employed in Vietnam had shown that only the most sensitive plant seedlings, soybeans, suffered ill effects six to twelve months later. Additional tests on soil taken from targets in Vietnam sprayed with single and double applications of white showed no effects on bean seedlings eleven to seventeen months after the spraying. Concerning the cacodylic acid used in blue, Minarik and Darrow said that field tests had shown that sensitive crops could be safely planted within days of a spraying with blue even at rates greater than those normally used in Vietnam. As to the water draining from defoliated areas, they said that so little herbicide remained after absorption by vegetation, adsorption by soil, and microbial and photochemical breakdown that it was very unlikely that enough would remain to be toxic in the watershed drainage from defoliated areas.[5]

In the latter part of 1968, the United Nations General Assembly adopted, without objection, a resolution calling for the convening of a United Nations Conference on Human Environment in 1972. While this resolution did not specifically address the question of herbicides in Vietnam, its passage indicated that the world body had become attuned to ecological issues. At about the same time, the General Assembly passed another resolution asking the Secretary General to prepare a report on chemical, biological, and bacteriological weapons. The General Assembly also considered endorsing the Geneva Protocol of 1925, an international treaty which the United States had not ratified. The Geneva Protocol banned " . . . the use in war of asphyxiating, poisonous, or other gases and all analogous liquids, materials, or devices and of bacteriological methods of warfare." While the U.S. was prepared to support an endorsement by the U.N. of this treaty, the American position was that the Geneva Protocol did not apply to herbicides, chemicals which were used domestically in the United States, USSR, and other countries to control unwanted vegetation.[6]

Since the AAAS had been unsuccessful in its attempts to persuade the United Nations or the United States to sponsor an on-the-spot study of herbicides in Vietnam, the organization decided to attempt such a study itself. At its annual meeting in December 1968, the board of directors asked the AAAS staff to convene an ad hoc group to prepare specific plans for a field study. The president of the association wrote to the Secretary of State in January 1969, requesting his help in assuring that a comprehensive study of the ecological effects of herbicides in Vietnam would be undertaken "as soon as conditions permit." By June no reply had come to this latest AAAS request, and the organization's efforts were temporarily at a standstill.[7]

Another pair of scientists did not wait for the AAAS actions to bear fruit. Professor E. W. Pfeiffer of the University of Montana, one of the original scientists pressing the AAAS to become involved in the herbicide controversy, had consistently called for objective scientific field studies in Vietnam. He viewed the MRI report of 1967 as a "snow job," and the assessment by Ambassador Bunker's committee the following year as too

general. Besides his activities within the AAAS on the herbicide question, Pfeiffer was also involved in 1968 in an attempt to get the Society for Social Responsibility in Science (SSRS) to organize a study in Vietnam. In late 1968, Pfeiffer announced his intention to conduct a reconnaissance survey in Vietnam under SSRS auspices, and, from March 17 to April 1, 1969, he and Professor G. H. Orians of the University of Washington, Seattle, did conduct limited research in Vietnam. MACV assisted them by allowing them to fly on defoliation missions, inspect sprayed areas from boats and helicopters, and talk with biologists in Saigon. Because of the brevity of the Pfeiffer and Orians visit, the information they collected was mostly restricted to qualitative data and hearsay.

In their preliminary report afterwards, the two scientists acknowledged that a guerrilla war lacking clear battle lines and fixed military targets had the inherent property of causing the destruction of lives and ecological communitites as the two sides sought to deny cover and resources and inflict casualties on each other. They reported that the Central Highlands were receiving agent white in a higher proportion than previously because of white's lower volatility. They found no evidence of adverse effects on bird life or mammals from the use of agent blue (cacodylic acid) which had been employed primarily against rice and other crops. Economic costs of herbicide use were in some cases very high, and they cited the costly effects of accidental damage to rubber trees. Also, they determined that the defoliation program posed a potential threat to the South Vietnamese timber industry since repeated applications of herbicide could kill about one half of the commercially valuable trees in the sprayed areas.

Upon his return from Vietnam, Professor Pfeiffer told the press in New York that it was "completely unrealistic" to expect American commanders in Vietnam to stop defoliation missions because the use of these chemicals unquestionably saved American lives. He said that he had seen few living plants on a journey by boat from Saigon to the ocean, but that if the vegetation along the way had not been killed, he would probably not have survived the journey.[8]

As the Nixon Administration began to implement its policy of reducing the American presence in South Vietnam, Ranch Hand came under increasing pressure to cut back on its operations. On August 20, 1969, Adm. John S. McCain, Jr., CINCPAC, requested General Abrams' reaction to a proposal to reduce herbicide operations to 25% of their current level by July 1, 1970.[9] On September 6, Abrams replied that the planned priority targets in the herbicide program for calendar year 1969 would require as a minimum the current average of four hundred sorties per month. Plans for 1970 were

not yet complete, but MACV expected continued high demand for defoliating border areas and infiltration routes and spraying enemy crops. Requirements near populated areas would drop as pacification progressed. The accelerating shift to border areas was expected to reduce problems from accidental herbicide damage. Abrams concluded that a reduction to 25% of the current level was unrealistic and that a shrinkage to 70% or 75% was more likely in the period before July 1. He assured his superior that his staff was continually reviewing the herbicide program with the object of reducing it as quickly as the tactical situation would permit.[10]

On September 18, 1969, McCain concurred in Abrams' recommendation and requested that herbicide operations be cut by 30% by the following July.[11] General Abrams then directed Seventh Air Force to reduce Ranch Hand sorties from the 400-per-month level which was to continue through October, by 20 or 30 sorties per month so as to arrive at a 280-sortie figure for the month of July 1970 and afterwards.[12] To bring the number of spray aircraft into line with these reduced herbicide requirements, in November 1969, the 12th SOS transferred eleven of its twenty-five UC-123Ks to other units along with eleven officers and two flight engineers. At about the same time, the spray planes lost the use of Nha Trang as a turnaround point because the base had been turned over to the VNAF.

The remaining Ranch Hand personnel could probably tell that their operation had a limited future after these reductions were achieved, because press coverage of the controversy over herbicides was increasing. A *Time* magazine correspondent flew two combat sorties with Ranch Hand in November, and, in December, an NBC reporter and television film crew accompanied the unit on two missions.[13]

On November 25, 1969, President Richard M. Nixon announced his intention to resubmit the Geneva Protocol outlawing chemical and biological warfare to the Senate for ratification. At the same time, the President reaffirmed the standing U.S. policy of renouncing the first use of deadly chemicals and extended it to include incapacitating agents. Also, he prohibited all uses of lethal biological weapons and "all other methods of biological warfare." However, it was still the position of the United States that the Geneva Protocol did not apply to herbicides and riot control agents. This interpretation suffered overwhelming rejection by the United Nations when, in December 1969, both a committee and the full U.N. General Assembly adopted resolutions declaring that the protocol applied to all chemicals used in warfare, with no exceptions for herbicides and tear gas. U.S. officials quickly declared that the U.N. action did not reflect an international consensus and that, in any event, the General Assembly had no power to resolve questions of international law such as this by majority vote. Still, this action by the United Nations added to the political burdens to be borne if the herbicide program in South Vietnam were to continue.[14]

For the period July 1970 through June 1971, MACV requested the Air Force to buy $27 million worth of herbicides to support the planned level of

spray activity. The Department of Defense, however, disapproved the Air Force's herbicide procurement request, cutting it back by almost 90%. Since continuing at the then current consumption rate would have exhausted all herbicide stocks by the end of November 1970, Headquarters, United States Air Force asked PACAF and MACV in early February 1970 to comment on three alternatives:

> 1. Continue spray operations at the present rate until exhausting the supply of herbicides and then withdraw the 12th SOS from South Vietnam.
> 2. Operate at the present rate through June 1970 and then reduce the 12th SOS to the minimum level needed to meet emergency spray requirements.
> 3. Reduce the 12th SOS to eight aircraft and ration herbicide missions so as to consume all the herbicide stocks by the end of June 1971.[15]

MACV protested the drastic reduction in herbicide operations that this cutback in funding would cause. The view of the American headquarters in Saigon was that the problem of providing an adequate level of surveillance and security in South Vietnam was becoming more critical as American forces withdrew from the country. The Command again cited the fact that tactical commanders credited herbicides with being one of the most economical and effective means of increasing visibility and assisting in the maintenance of the security of lines of communication, widely separated installations, and base camps. If more money could not be found to support herbicide operations at the level originally requested, MACV wanted to save herbicide resources for use only against priority targets. The Ranch Hand aircraft could fly airlift missions when not needed for these priority herbicide targets.[16] Although more money for herbicides was not forthcoming, the Air Force was able to fulfill MACV's request for a continuing capability to spray high priority targets. In late March, Headquarters, United States Air Force directed that the 12th SOS would be reduced to eight aircraft by the end of June. Two of these aircraft were to be configured for spraying insecticides. This force of Ranch Hand planes would be able to meet MACV's priority needs within budgetary limitations.[17]

While plans for the reduction in forces went ahead, the problem of ground fire continued to plague Ranch Hand in the early months of 1970. A spray mission of five UC-123Ks over a target in the U Minh Forest on January 19 received fourteen hits from the ground. Less than a week later, over another target in IV Corps, one spray plane had to shut down an engine and land at Binh Thuy because of damage from ground fire. The worst incident of the period occurred on February 21 over a defoliation target along a canal in IV Corps. Three Ranch Hand planes were struck thirty-one times, and one of them lost its entire electrical system. Ranch Hand still employed heavy suppression tactics over targets where significant ground fire was likely, but a new wrinkle was tried in early 1970. On a few missions, fighters dropped tear gas bombs on the target ten minutes or less before the spray planes began their run. The fighters then returned and flew ten or fifteen seconds ahead of the UC-123Ks dispensing ordinary explosive CBUs. This use of tear gas in conjunction with Ranch Hand missions soon ended.[18]

On April 6, 1970, Seventh Air Force ordered Ranch Hand to deploy three aircraft to Da Nang to augment the four spray planes already there for a special crop destruction operation planned for April 10 and 11 in the Be river valley of Quang Ngai Province. Four F-100 fighters along with six UH-1 and ten Cobra helicopter gunships accompanied this seven-ship formation over the target. Very early in the spray run, enemy gunners opened up on the Ranch Hand planes with intense small arms and automatic weapons fire. The lead aircraft, piloted by Lt. Col. Warren P. Fisher, the commander of the Da Nang detachment, lost its right piston engine about midway through the spray run. Colonel Fisher dumped the remainder of his herbicide load and flew to Chu Lai where he made an emergency landing. His UC-123K had been hit twelve times, and the seven planes together received 37 hits over this crop target.[19]

The controversy over the use of herbicides also continued as reductions in Ranch Hand operations were argued. In the fall of 1969, a report authored by K. Diane Courtney and others, and prepared for the National Institutes of Health, had presented evidence that 2,4,5-T, a component of herbicide orange, could cause malformed babies and stillbirths in mice when it was administered in relatively high doses.[20] In response to this report, the Deputy Secretary of Defense, David Packard, had directed the Joint Chiefs to insure that orange would be sprayed only in areas remote from population pending a decision by the appropriate government agencies about whether 2,4,5-T could remain on the U.S. domestic market. Secretary Packard said further that the normal use of herbicides white or blue could continue, but that the large-scale substitution of these two herbicides for agent orange must not occur.[21] This restriction did not significantly affect Ranch Hand operations, since most defoliation missions by this time were already taking place in remote areas due to President Thieu's request of the previous year.*

Dr. Lee A. DuBridge, the science advisor to President Nixon, referred the study questioning the safety of 2,4,5-T to the Weed Society of America for comments and an evaluation. On December 22, 1969, Glenn C. Klingman, the president of the organization, along with a group of other scientists sent their joint reply to Dr. DuBridge with copies to various government officials, members of Congress, and chemical companies. Kingman's

*The Courtney study had been preceded by published reports in South Vietnamese newspapers beginning on June 26, 1969, alleging that herbicide orange had caused human birth defects in that country. See Rprt, USAF Occupational and Environmental Health Laboratory, subj: The Toxicology, Environmental Fate, and Human Risk of Herbicide Orange and its Associated Dioxin, Oct. 1978, p V-14.

group of reviewers saw multiple problems with using the Courtney study as a basis for determining the hazard to human populations posed by 2,4,5-T. Their first criticism was over the use of dimethylsulfoxide (DMSO) as a solvent for the herbicide in these tests. They said that because DMSO was rapidly absorbed and transported to all parts of the body, it was likely that the 2,4,5-T reached internal organs that it would not have otherwise. Also, they criticized the use of subcutaneous injections as a completely artificial treatment method when compared with natural exposures to 2,4,5-T. In addition, Klingman's group argued that oral dosages used in the test were massive when compared with normal exposures. They concluded that the study by the Courtney group did not support the conclusion that 2,4,5-T contributed to birth defects when used as instructed on the product's label and they advocated a review of the restrictions which had been placed on the herbicide.[22]

Within a few days of the Klingman letter, the AAAS adopted an opposing view concerning herbicides in Vietnam. On December 27, 1969, the AAAS Council adopted a resolution which stated that recent studies had shown that both 2,4-D and 2,4,5-T could cause birth deformities in experimental animals, thus supporting the conclusion that 2,4,5-T posed a probable threat to man, while 2,4-D was a possible danger. The AAAS also maintained that the levels of application of 2,4-D and 2,4,5-T in Vietnam were greater than the normal dose rates in civilian usage and that these herbicides might be causing birth defects in human babies there. The resolution concluded by calling on the Department of Defense to cease immediately using these two chemicals in Vietnam.[23]

On January 19, 1970, an assistant to Dr. DuBridge wrote to Admiral McCain asking for his opinion of the merits of investigating allegations of human birth defects caused by herbicides and pesticides in South Vietnam. McCain replied within a few weeks and said that every reasonable effort should be made to either prove or disprove these allegations. However, he thought it would be difficult, if not impossible, to conduct a study which would have any scientific validity, and the result of an inconclusive effort would simply be to intensify the controversy over herbicides without actually resolving anything. The foremost problem would be collecting data about birth deformities in South Vietnam where few births took place in hospitals and where records were generally incomplete or nonexistent.

McCain also noted that the herbicide program had been under attack in recent years by portions of the U.S. scientific community, antiwar elements, and the National Liberation Front (NLF), the political arm of the Viet Cong. He said that rumors of birth defects caused by herbicides had recently become more numerous and that antiwar activists were extensively exploiting the issue. Viet Cong propaganda had been directed toward arousing resentment over the use of herbicides through the spreading of charges like ". . . U.S. poison substances have killed fetuses and seriously affected milk secretions of mothers, rendering them unable to feed their babies."

Top: lawn in front of the U.S. Department of Agriculture, sprayed with 2,4–D to destroy weeds as early as March 1946; bottom: 2,4–D control of weeds—before and after.

In short, McCain viewed conducting a scientifically valid study of possible birth defects caused by herbicides in Vietnam as completely impracticable. As an alternative, he suggested a study of the possibility of genetic defects from herbicides in the United States where essentially the same compounds had been in use for more than 20 years and where medical records were much better.[24]

In early April 1970, the Department of Defense learned that on the morning of April 15, the Secretary of Health, Education and Welfare, the Secretary of the Interior, and the Secretary of Agriculture planned to announce in a joint statement, immediate suspension of all use of 2,4,5-T except for carefully controlled and registered applications on non-crop land such as ranges and pastures. The Director of Defense Research and Engineering, Dr. John S. Foster, Jr., informed Secretary of Defense Melvin R. Laird and reminded him that 2,4,5-T was a major component of the herbicide orange being used in Vietnam at the current rate of 150,000–200,000 gallons per month. Foster noted that agent white could be substituted for orange, but only about 100,000 gallons of white were in Vietnam, enough for approximately fifteen more days of defoliation spraying at the current level of operations. Dow Chemical Company could produce over 200,000 gallons of white if given thirty days to do so. However, Foster pointed out that white was somewhat more expensive than orange and was also more persistent in the soil, increasing the likelihood that long-term ecological damage would result if white replaced orange in large quantities.

As Foster saw the situation, the Defense Department had three choices concerning the future of agent orange. First, it could continue the present policy which stated that this chemical could only be used in areas remote from population. Or, Secretary Laird could endorse the positions of the other three executive departments and direct that orange be applied only to sparsely populated, non-agricultural areas while at the same time avoiding ponds, lakes, and rivers. Finally, Laird could temporarily suspend the use of orange pending further study and the establishment of specific guidelines for future use. Foster argued against the first two options because they would probably cause adverse public reaction. Also, the second option would be confusing without specific criteria for immediate use in answering inquiries. The Chairman of the JCS favored the second option, however, because he felt that restrictions tighter than those governing civilian uses of 2,4,5-T should not apply to military uses and because a temporary restriction, once in place, would be very difficult to remove. Foster, on the other hand, favored the last option. He felt it would be quite difficult to apply criteria applicable to civilian uses of 2,4,5-T in the United States to military operations in Southeast Asia.[25] Foster's view prevailed, and, on April 15, 1970, the Deputy Secretary of Defense informed the Joint Chiefs that "The Department of Defense will temporarily suspend the use of 2,4,5-T (orange) in all military operations pending a more thorough evaluation of the situation."[26]

The JCS message directing the suspension of herbicide orange use also asked both CINCPAC and COMUSMACV for their evaluation of the military impact of this action.[27] General Abrams replied within days and recommended that the ban on orange be lifted to allow it to be sprayed, as under the previous policy, on enemy-controlled areas with very low population densities (less than eight inhabitants per square kilometer). As an alternative, he asked for 128,000 gallons per month of white or a suitable substitute. Admiral McCain on April 24 reaffirmed the operational requirement for herbicides and endorsed Abrams' call for removing the restriction on orange or procuring a substitute. He also objected to the limitations on orange in Vietnam being greater than those on 2,4,5-T in the United States.[28]

On May 14, 1970, Admiral Thomas H. Moorer, as acting Chairman of the JCS, petitioned Secretary Laird to lift the temporary ban on orange. He presented this as the best of three options, with the other two being to terminate defoliation operations or to buy enough white to replace the orange. He said that ending all defoliation would take away from General Abrams an important capability to reduce jungle concealment and expose enemy camps, storage locations, and lines of communication. Defoliation enabled fewer military personnel to provide security around fixed installations and had helped to save lives. Moorer did not favor white as a substitute for orange, since defoliation took four months with white as compared to three or four weeks with orange.[29]

Because no decision was immediately forthcoming, Gen. Earle G. Wheeler, the Chairman of the JCS, wrote to Laird on June 2 asking for the earliest possible decision on the continued use of orange.[30] The answer finally came on June 22, 1970, in a JCS message to CINCPAC and MACV announcing that Deputy Secretary of Defense David Packard had decided to continue the suspension of orange.[31]*

Ranch Hand received notification of the original prohibition against further use of the herbicide orange through Seventh Air Force channels on April 19. Since orange was no longer available, all defoliation missions previously planned for this herbicide mixture had to be shifted to white. After exhausting stocks of white at Bien Hoa, the unit began drawing down the supply at Phu Cat. The procedure used was to start from Bien Hoa with a loaded UC-123K, spray the target, land at Phu Cat for more fuel and herbicide, and then return to Bien Hoa where the crews parked the planes with their chemical tanks full for the next day's flights. On May 9, 1970, Ranch Hand flew its last defoliation (but not crop destruction) mission of the war,

*Between the original ban on orange and this June decision by Secretary Packard, the American ground operation in Cambodia and the accompanying campus protests in the United States, including the shooting deaths of students at Kent State University, had occurred. The public opinion costs for the Administration in continuing the war in Southeast Asia were increasing, and the prevailing atmosphere was against making any decisions which would generate any unnecessary controversy. Lifting the restrictions on herbicide orange would certainly have generated controversy.

spraying 2,500 gallons of herbicide white near Bu Nard airfield. At this point, Ranch Hand found itself with nothing to spray. Approved crop targets against which herbicide blue could be used were not yet at a sufficiently advanced stage of maturity.[32]

Since the 12th SOS had no herbicide missions to fly for a while, Seventh Air Force directed the unit to prepare for leaflet drops and flare missions in support of the ground operation which was then underway in Cambodia. Ranch Hand, which by this time had only six herbicide spray UC-123Ks plus the two used for spraying malathion to control mosquitos, began leaflet operations on May 11. On May 16, flare drops began over Cambodia. These leaflet and flare missions continued until July 4 and 6, respectively.[33]

Because of the decline in Ranch Hand's herbicide mission and the accompanying reduction in the number of spray aircraft, it became increasingly unnecessary to have a separate squadron devoted solely to this purpose. On July 2, 1970, PACAF approved the inactivation of the 12th SOS. The 315th Tactical Airlift Wing (TAW) then ordered the Ranch Hand planes and crews to relocate from Bien Hoa to Phan Rang where they would become A Flight of the 310th Tactical Airlift Squadron. This move took place on July 8, 9, and 10, and the 12th Special Operations Squadron formally passed out of existence as a separate organization on July 31, 1970.[34]

In early July, Ranch Hand had received word to prepare to resume flying herbicide missions. This presented a problem—the crews had lost some of their proficiency in spray tactics during the previous two months, and some of the newly arrived crew members had no combat experience in spray work. To remedy this situation, Ranch Hand began flying spray training missions from its new base at Phan Rang on July 16, 1970. Another obstacle to future herbicide operations was the fact that the South Vietnamese province chief would not allow Ranch Hand to store herbicide at its new home base of Phan Rang longer than overnight. The remaining herbicide stocks were at Da Nang, Phu Cat, and Bien Hoa. As a result, the unit could only fly herbicide missions on alternate days with the intervening day used to fly to one of the storage locations to load herbicides for the next mission.

On July 17, 1970, General Abrams permanently cancelled any future fixed-wing defoliation missions. On July 20, Ranch Hand flew against its first crop destruction target since the break in spray operations in May. On July 22, the unit sprayed another area of crops about 20 miles west of Nha Trang. Ground fire was intense over both of them. To counter ground fire on future missions, Ranch Hand employed heavy suppression. Tactics were also changed. Prior to that time, the planes flying crop destruction missions had maintained a rather loose formation because of the irregular pattern of agricultural fields in the target areas. Individual aircraft might break away completely from the formation to spray isolated fields. After experiencing heavy ground fire in late July, future flights of crop destruction aircraft flew a tighter formation so that the suppression of ground fire by the accompanying fighters would have the greatest possible effect.[35]

Another event which helped to hasten Ranch Hand's demise was a visit to South Vietnam by a group of scientists from the American Association for the Advancement of Science. At its meeting in December 1969, the AAAS Board of Directors had charged Professor Matthew S. Meselson of Harvard with developing a plan for a study of the effects of the large scale use of herbicides on South Vietnam's ecology and population. The AAAS allocated $80,000 for the project. Meselson selected Professor Arthur H. Westing to head the AAAS Herbicide Assessment Commisson (HAC), the name given to this activity. To begin its work, the HAC reviewed the scientific literature and consulted with knowledgeable individuals from the U.S., Vietnam, and other countries. In June 1970, the HAC held a conference at which twenty-one specialists identified the areas which needed further investigation.[36]

The next stage of the HAC's activities was a trip to Vietnam in August for a thirty-day survey of conditions there. On July 25, the State Department informed the American Embassy in Saigon that a four-man team would soon be arriving from the AAAS, " . . . a private organization with no official status, but with high standing within scientific community . . . . " State also informed Saigon that the purpose of this suvey would be " . . . to determine feasibility of detailed study at a later date . . . ." The Defense Department's view, however, was still that the military situation in South Vietnam was not conducive to conducting scientific studies, but that such efforts would be welcomed and supported later after peaceful conditions had returned to the country. The State Department asked the Embassy in Saigon to meet the Meselson group at the airport, assist them in obtaining accommodations and transportation, and provide introductions to the various officials and scientists they desired to meet. Although State suggested a positive approach to this group's visit, it emphasized that these scientists had no official status and that the normal directives governing the disclosure of classified information to private individuals would apply. In addition, officials from the State Department, AID, and the Defense Department had clearly explained the difficulties this survey team would encounter in the wartime conditions prevailing in South Vietnam.[37]

Upon their arrival in Vietnam, Meselson's team, which included Westing, Dr. John D. Constable of the Harvard Medical School, and Robert E. Cook, Jr., a Yale graduate student in ecology, received a great deal of assistance from the American Embassy and MACV. In Vietnam, they traveled in helicopters, small boats, and automobiles provided by American officials and used government facilities for their meals and lodging. Their accesss to Americans in South Vietnam was extensive, including meetings with Ambassador Bunker and General Abrams. A serious conflict developed, however, over the issue of access to information about specific spray missions including dates, locations, and chemicals used. This information was at that time classified confidential. Meselson's team felt that they needed this data to correlate the samples they collected with the types

and amounts of spray received in the area. Meselson pressured Embassy officials in Saigon, including Ambassador Bunker, to give the information to him, but MACV and CINCPAC strongly resisted. The MACV information office was suspicious of leaks and the possible inadvertent release of classified information. The office felt that since the Meselson team was working together so closely, showing the data to one of them would be the same as giving it to all four. Following a query by CINCPAC on August 11, the Joint Chiefs reaffirmed the decision not to release classified herbicide mission data to Meselson, citing the additional argument that his team's trip to Vietnam was only a survey visit and that the detailed information he sought would only be applicable to a later, extensive study and not to the feasibility survey he was supposedly doing. Although Meselson did not at that time receive the data he wanted, *Science* magazine published an account of the episode and thereby added to the negative public relations fallout the herbicide program was generating.[38*]

In November 1970, Meselson and Constable wrote to Ambassador Bunker informing him that on August 21 and 28 they had flown over an area of Quang Ngai Province sprayed by Ranch Hand crop destruction missions a few days before. They said that American officials had told them that this was a crop production area for the Viet Cong and the North Vietnamese Army and that most of the destroyed food had been destined for enemy soldiers. Meselson and Constable disagreed with this interpretation, arguing that the number of civilian dwellings in the target area and the number and size of the fields were more consistent with a population of Montagnards growing just enough food to feed themselves. They said that their observations of this one target lent credence to previous studies which had maintained that nearly all of the food destroyed by chemical crop destruction would have been eaten by local civilians rather than enemy soldiers. They strongly urged Ambassador Bunker to review the crop destruction program in light of this challenge to its basic justification.[39]

Meselson's group presented a preliminary report on their trip to the AAAS meeting on December 30, 1970. They said that their inspection of sprayed mangrove areas had revealed little regeneration of the forest after three or more years. In sprayed tropical hardwood forests, they found large areas of dead trees where bamboo had spread over the forest floor. The bamboo, they feared, would retard the regeneration of the larger trees. They also feared that the sudden death of many trees might have released the plant nutrients contained in the vegetation too quickly and that tropical rains could have carried them away, seriously lowering the soil's fertility. (This phenomenon is known as "nutrient dumping.") Meselson and his colleagues also looked into the possibility that either or both 2,4,5-T and its associated dioxin had caused birth defects in South Vietnam. They found that

*The data Meselson sought is currently available in unclassified form on the HERBS tape maintained by National Archives Machine Readable Archives Division.

the existing birth records in South Vietnam were inadequate to either prove or disprove a connection between the herbicide program and birth defects, and they suggested alternate approaches to investigating this question. Finally, the report repeated Meselson's earlier assertion that the civilian population would have consumed nearly all of the food destroyed by the crop destruction program.[40]

With agent orange banned and the fixed-wing defoliation program effectively terminated, it was only a matter of time before the political pressures also put an end to crop destruction, Ranch Hand's remaining mission. On June 16, 1970, Dr. Ivan L. Bennett, Jr., a White House scientific advisor, wrote to Dr. Lee A. DuBridge urging that crop destruction in Vietnam be completely halted. Bennett argued that the Geneva Protocol, soon to be formally submitted to the Senate, would likely become embroiled in controversy over the continued use of tear gas and herbicides in Vietnam. He said that although he had not been able to produce convincing arguments against the military effectiveness of tear gas and herbicides used for defoliation, he thought that the benefits of crop destruction were questionable while the political costs were high.[41] DuBridge endorsed Bennett's view a week later in a letter to Dr. Henry A. Kissinger, the Assistant to the President for National Security Affairs. [42]

On July 6, 1970, President Nixon himself asked Secretary Laird to assess the value of the herbicide crop destruction program to the overall U.S. military effort in Southeast Asia.[43] At the request of the Joint Chiefs, CINCPAC provided a detailed evaluation and justification for crop destruction on July 11. Admiral McCain repeated the claim that crop destruction was an integral part of the resources denial program in South Vietnam and had been since 1962. He said that crop destruction was the most efficient and effective method to keep food which the South Vietnamese could not seize through ground operations from reaching enemy troops. To support his view of the value of crop destruction, McCain cited several incidents, including one in Laos where he attributed a significant role in Gen. Vang Pao's capture of the Plain of Jars to crop destruction missions which had taken place in August 1969. In short, McCain said that both he and Abrams considered crop destruction an essential element of combat support and an important part of the pacification and Vietnamization programs.[44]

Laird replied to Nixon by way of a memo to Kissinger on July 18, 1970. He basically repeated CINCPAC's arguments, stating that herbicides used against crops were an integral part of the resources denial program in I, II and III Corps areas of South Vietnam. He said that crop destruction had

adversely affected the enemy through lowering morale, increasing defections, and putting an added strain on the supply system. In summary, Laird felt that crop destruction had proven itself "an effective adjunct to our total military effort in Southeast Asia."[45]

President Nixon did not decide to end the crop destruction program at that time, and the political fallout from herbicides continued through the latter part of 1970. During the week of October 19, the American news media reported on an unauthorized use of herbicide orange in the area of operations of the U.S. Army's Americal Division. An investigation by MACV revealed that on several occasions during June, July, and August 1970, personnel of the Americal Division had dispensed approximately 5,500 gallons of orange by hand pump and helicopter spray over remote areas of Quang Tin and Quang Ngai provinces to defoliate base perimeters and to destroy crops. The division chemical officer had ordered the use of orange in violation of MACV directives, but he had done so with the approval of the division's operations officer and had falsified chemical reports to hide his actions. Furthermore, chemical officers at XXIV Corps and MACV had known of the situation but had taken no action either to report it or to stop it. One of the factors which may have led to this unauthorized use of orange was the fact that stocks of white, a substitute for orange, had been depleted in May. New shipments of white did not arrive until October 1970. To prevent such incidents from recurring, all stocks of orange possessed by U.S. units within South Vietnam were consolidated at central storage points where they were under tighter controls.[46]

In early December 1970, Ambassador Bunker and General Abrams decided, on the basis of a report prepared by their staffs in Saigon, to completely phase out the crop destruction program. General Abrams stopped any further procurement of white and blue herbicides. The herbicide stocks on hand in South Vietnam were adequate to defoliate base perimeters and to carry out highly selective crop destruction missions until about May 1971. In accordance with the precedent set when they suspended the fixed-wing defoliation portion of the herbicide program earlier in 1970, Bunker and Abrams planned to make no public announcement of their decision to end crop destruction. This, they felt, would allow them to quietly, orderly, and rapidly phase out the program while preserving the option to resume destroying crops in the future if this became necessary.[47]

Additional factors leading to this decision may have included the unsuccessful effort during the summer of 1970 by Senators Gaylord Nelson and Charles Goodell to persuade the Senate to cut off all funds for further crop destruction operations. Although their attempt garnered only twenty-two votes, it did add to the controversy. Also, prior to the Bunker and Abrams decision, a committee of South Vietnamese appointed by President Thieu had concluded that herbicides had destroyed twenty percent of South Vietnam's forests. They had urged President Thieu to ask the Americans to stop the spraying.[48]

Events in Washington compressed the Bunker-Abrams timetable, however. On November 20, 1970, Dr. Edward E. David, Jr., President Nixon's science advisor and Dr. DuBridge's successor, wrote to Dr. Kissinger and recommended the reconsideration of U.S. herbicide policies in Southeast Asia. David said that he had reason to believe that the AAAS' Herbicide Assessment Commission would report to the Senate Foreign Relations Committee and to the public that the herbicide orange in Vietnam contained a level of dioxin higher than the level permitted for herbicides in use in the United States. Dioxin was at that time known to cause birth defects in experimental animals, and researchers suspected the chemical was able to cause damage to human fetuses if ingested by their mothers in sufficient quantities. Also, David informed Kissinger that all of the candidate substitutes for orange had drawbacks—2,4-D was a suspected carcinogen and picloram was persistent and a soil sterilant. David felt that the current policy combined with these scientific findings might cause trouble during the upcoming hearings on the Geneva Protocol, and he urged Kissinger to propose to Nixon that the U.S. state that it would only spray in Vietnam those chemicals approved for use in the United States under the same governing restrictions.[49]

On December 7, 1970, Secretary Laird informed the Chairman of the JCS and the Secretary of the Army that he had decided to continue to supply the South Vietnamese with both riot control agents and herbicides at a level based on appropriate military and economic considerations.[50] Three days later, Dr. Kissinger asked Secretary Laird to assess the impact of adopting the policy proposed by Dr. David, that is to use herbicides in Vietnam only under the same rules applicable in the United State. Laird asked the Joint Chiefs for their opinion, and they replied on December 18, reiterating their endorsement of the military value of herbicides in Southeast Asia. They said that there were no direct parallels between the ways herbicides had been used in Southeast Asia and normal domestic uses. Complying with the current Department of Agriculture standards of no more than one-half to one part per million (ppm) of dioxin in 2,4,5-T would not be feasible because some of the orange in storage in South Vietnam contained higher levels of dioxin, and no testing facilities existed in Vietnam to determine the level of dioxin contamination in each drum. In any event, the Chiefs argued that the scientific evidence concerning the alleged danger from 2,4,5-T and dioxin was weak and did not justify a continuation of the suspension placed on the use of orange. They cited a study done of a test range at Eglin AFB, Florida, which had received more than 500 pounds of orange per acre over the past eight years, compared with about 25 pounds of herbicide deposited per acre during a single spraying in Vietnam. Investigators had found no detectable dioxin in the soil of this test area, and there were no abnormalties in the animals living there. In short, the JCS saw no factual basis for restricting orange in areas remote from population, and they argued for maintaining the option to continue the herbicide program.[51]

After receiving the views of the Joint Chiefs, Secretary Laird responded to Dr. Kissinger, but he did not adopt the JCS position. He said that the overall military impact of implementing Dr. David's policy recommendation would be minimal considering that 95% of the South Vietnamese population lived in relatively secure areas and that the rapid progress of the pacification program had made herbicides relatively less important. However, Laird said that the option of conducting future herbicide operations had to be preserved and that the South Vietnamese needed to be provided with the capability to do so. He specifically disagreed with the JCS on the matter of herbicide orange, saying that the adverse political and psychological costs of using the 1.63 million gallons of the chemical then in South Vietnam would outweigh the dollar value of its original purchase price (about $12 million) and the expense of disposing of it (estimated at over $6 million). He told Kissinger that he had directed the JCS to produce a plan for disposing of all orange not meeting U.S. Department of Agriculture standards and had decided to continue the ban on orange use pending further studies. Secretary Laird further stated that if President Nixon so directed, he would be willing to apply Department of Agriculture standards to future herbicide operations in South Vietnam.[52]

Three days after the Joint Chiefs sent their first memo on herbicides to Secretary Laird, the Chairman of the JCS sent another stating that the Chiefs did not agree with Laird's announced decision to make the temporary ban on herbicide orange permanent.* Admiral Moorer emphasized again that in the Chief's view every new study had not only failed to support the original suspension of orange, but had shown that the risk of human injury from this herbicide was even less than originally suspected. He also outlined again the problem of disposing of the 1.6 million gallons of orange in Vietnam and the 800,000 gallons in the U.S. He said, " . . . if, for purely public relations reasons, you determine it necessary to make the ban on orange permanent . . . , " essentially the same techniques used in destroying mustard gas would be needed, at a probable cost in excess of $10 million.[53]

The protests of the Joint Chiefs were to no avail. On December 22, 1970, Laird informed Nixon that, in the future, the use of herbicides in Vietnam would be in strict conformance with policies governing their use in the United States and that the ban on herbicide orange would remain in effect. He mentioned to the President that Ambassador Bunker and General Abrams had decided on an orderly yet rapid phase-out in spraying other herbicides, but they also retained the option to continue their use if necessary to protect American lives. Laird said that during this phase-out period, herbicide use would be restricted to remote, unpopulated areas and the vicinities of firebases and U.S. installations, limitations similar to those

*Dr. David had proposed this change on December 18.

in force in the United States. Also, he recognized that there could be some temporary risks to American forces because of these decisions on herbicide use, and he cautioned Nixon that the policy might need to be reassessed if increased enemy activity threatened American forces as they withdrew.[54]

Public announcements of these policy decisions occurred during the last week of December 1970. A White House statement on the 26th revealed the substance of Laird's December 22 memo to Nixon, without mentioning the possibility of reassessing herbicide policy in light of future enemy actions.[55] In addition, Secretary Laird learned on the 28th that the President wanted any plans to extend or expand the herbicide program or to Vietnamize it submitted for his personal approval.[56] On the 29th, the Department of Defense released the following statement:

> Secretary of Defense Melvin R. Laird has, as we have previously reported, taken steps to insure that herbicide usage in South Vietnam will conform to the policies governing usage in the United States. As a result, the stresses and risks involved in South Vietnam will be no greater than those sustained by the United States population and the United States environment in normal peace-time activities.
>
> Deputy Secretary David Packard last spring restricted all use of defoliant orange, and that ban remains in effect. In addition, at that time use of other defoliants (blue and white) was strictly limited to areas remote from population.
>
> General Abrams is now initiating in South Vietnam an orderly phase out of the herbicide operations to be completed by next spring.
>
> It is important to note that estimated herbicide coverage for 1970 through September is 75 percent less than for the same period in 1969.[57]

During the last quarter of 1970, Ranch Hand flew only forty-three crop destruction sorties, with nineteen in October, eighteen in November, and only six in December. By way of contrast, the two insecticide aircraft flew a total of 133 sorties during this same period.[58] The last Ranch Hand herbicide mission of the war sprayed a crop target in Ninh Thuan Province on January 7, 1971.[59] On January 16, Deputy Secretary of Defense David Packard ordered the immediate termination of all crop destruction operations by U.S. forces.[60] The Joint Chiefs informed CINCPAC of this decision on January 22.[61] Since there was no further mission for Ranch Hand, the 310th TAS absorbed its A Flight spray planes and crews on January 28, 1971. This released the six herbicide spray UC-123Ks for cargo hauling duties. The two insecticide aircraft continued their mosquito spray mission. On February 11, 1971, one of the two crashed, killing all five men aboard.[62*]

*Admiral McCain on June 27, 1971, proposed a new use for the herbicides and spray systems stored in South Vietnam—against opium poppies, the source of heroin, which contributed to the drug abuse problem in the United States. The United Nations, he said, might become involved in this effort. The JCS responded on July 3 and stated that they would examine the idea in collaboration with the State Department and the Secretary of Defense, but that major political barriers existed. See Item of Interest AFXOOSO, Maj. R.C. Pyatt, July 12, 1971.

X. Epilogue

After the elimination of the Air Force's role in herbicide operations and the disbanding of Ranch Hand, there still remained three important questions concerning herbicide policies in South Vietnam: First, would U.S. forces be permitted to use herbicides in the future, and, if so, for what purposes and how long? Second, what would be done with the stocks of agent orange remaining in the country? Third, what, if any, herbicide capability would the United States provide to the South Vietnamese? Answering these interrelated questions involved much deliberation among Secretary Laird, Secretary of State William P. Rogers, President Nixon, and U.S. officials in South Vietnam.

The Senate Foreign Relations Committee held hearings on the Geneva Protocol scheduled for early 1971, and prior to these hearings, Secretary Rogers sought to persuade President Nixon to announce a decision to immediately stop all uses of herbicides, in any form, for military purposes in Vietnam. Rogers thought that the Administration was in a good position to obtain the Senate's approval for the Geneva Protocol, but he felt that the issue of chemical herbicides had generated serious problems on Capitol Hill, especially among the members of the Foreign Relations Committee. Rogers noted that three important members of this committee, Senators Clifford Case, John Cooper, and Jacob Javits, had voted for a measure cutting off the money for crop destruction in August 1970. Although Rogers felt that Nixon should affirm the previous U.S. position that the Geneva Protocol did not apply to herbicides, he thought an immediate announcement of an end to herbicide use would " . . . do much to help reduce opposition in the Senate to advise and consent to the Protocol."[1]

Secretary Laird shared Rogers' view that the U.S. should reaffirm its interpretation of the Geneva Protocol, but he did not agree that all military usage of herbicides should immediately stop. He reminded Nixon that the same restrictions applied to the use of herbicides in Vietnam as applied in the United States, plus, in Vietnam, operations took place only in remote, unpopulated areas and around firebases and U.S. installations. Also, the Department of Defense had ended the crop destruction program on January 16. Accordingly, Laird told Nixon, herbicides were exposing the land and people of Vietnam to no greater risks than those experienced in the United States. Herbicides were, in Laird's view, essential around firebases, other installations, and lines of communication to improve security as more American troops withdrew. He said that he would seek Nixon's approval for any extension of herbicide use beyond May 1, 1971, and that his department was preparing, for Nixon's consideration, a proposal for giving the South Vietnamese an herbicide capability. Laird's view prevailed with Nixon, and herbicide use in South Vietnam continued.[2]

A further tightening of the limitations on herbicides occurred in March, although it had little, if any, practical impact. The authority granted in previous years to COMUSMACV to conduct herbicide operations outside South Vietnam was still valid, and the Assistant Secretary of Defense for International Security Affairs, G. Warren Nutter, felt that it should be withdrawn for two reasons: first, any use of herbicides in Laos or elsewhere after the phase-out in South Vietnam might incite public criticism, and, second, recent Senate inquiries had asked whether the new herbicide policies applied to Laos and Cambodia.[3] Laird adopted the ISA advice and on March 18, 1971, requested the Chairman of the JCS to insure that any proposal for U.S. herbicide operations in Laos, Cambodia, or Thailand be submitted to Laird for his approval.[4]

Secretary Rogers was justified in his fears that herbicide policies in Vietnam would cause problems during the Senate Foreign Relations Committee hearings. These public hearings, held March 5–26, 1971, provided a forum for several opponents of herbicides such as Meselson and Westing to present their views. The committee decided to take no immediate action on ratification. Senator J.W. Fulbright, the chairman, wrote to President Nixon on April 15 saying that after listening to the testimony, many members of his committee felt that the United States should not ratify the Geneva Protocol with understandings attached exempting herbicides and tear gas from its coverage. Fulbright urged Nixon to drop these exemptions, saying, " . . . I personally believe that were you to take this initiative your action would be regarded as truly courageous and possessed of real moral force."[5]

Packard's directive of January 16, 1971, ending crop destruction operations had also asked the Joint Chiefs to produce by April 15 a plan for disposing of herbicide orange stocks.[6] MACV forwarded its views on a range of alternatives on March 8. General Abrams' preferred option was to remove all orange stocks from Vietnam. His second preference was to have the orange incinerated in South Vietnam under the control of the U.S.[7] Admiral McCain viewed having U.S. forces spray the orange in support of the South Vietnamese as the best alternative, with removing the chemical from the country as his second choice.[8] The plan the Joint Chiefs forwarded to the Secretary of Defense on April 23, 1971, generally followed CINCPAC's preferences. The Chiefs asked once more for the lifting of the ban on herbicide orange so that it could be sprayed in remote areas. And, they said that the stocks of orange in Vietnam should remain the property of the South Vietnamese government for future use after they acquired spray capabilities under the Vietnamization program. If the ban on orange had to remain in effect, the Chiefs wanted the orange returned to the United States for destruction by burning. For stocks of orange stored at Gulfport, Mississippi, the Air Force had developed a plan to offer that portion with an acceptably low dioxin content for use by the government or for commercial sale and to destroy the rest by controlled burning.[9]

With the May 1, 1971, date approaching and American forces still in South Vietnam, American commanders sought to have the deadline for herbicide use extended. In April, General Abrams informed his forces that unless further authorization came in time, they were to stop all use of herbicides by May 1.[10] The Joint Chiefs asked for continuing authority to spray base perimeters with herbicides blue and white. On April 28, Ambassador Bunker concurred in this request, noting that there was no satisfactory substitute for herbicides on base perimeters seeded with mines and trip flares.[11] Secretary Laird considered a request to President Nixon for an extension, but his Principal Deputy Assistant Secretary of Defense for Public Affairs, Jerry W. Friedheim, advised against it. Friedheim said that the Administration had lived up to all its previous commitments about Vietnam, and to reserve the policy on phasing out herbicides would create a major public affairs problem on this emotional issue.[12] Assistant Secretary Nutter, however, supported the Joint Chiefs' request, in spite of expected State Department opposition, and the ISA staff prepared for Laird a memo to Nixon about the matter.[13]

On May 13, 1971, Laird asked the President to extend the date for herbicide use by U.S. forces to December 1, or until the South Vietnamese could take over the job, whichever came sooner. He said that his staff was currently evaluating a JCS plan for giving the Vietnamese a limited herbicide capability, which he would forward to Nixon for his consideration. In the meantime, Laird supported the plan to use herbicides around installation perimeters and their associated fields of fire where mines, booby traps, and barbed wire made mechanical methods hazardous. He said this was vital to protect American and allied forces as the Americans withdrew, because enemy forces had been placing more reliance on sapper attacks and ambushes which took advantage of vegetation for concealment.[14]

As expected, the State Department opposed any extension of herbicide use. Secretary Rogers argued that a public expectation had developed that herbicides would be phased out during the first half of 1971, and an extension might provoke charges that the Adminstration had misled both the American public and the Senate Foreign Relations Committee. This could revive efforts in Congress to cut off funding for herbicides and might further complicate the ratification of the Geneva Protocol. Rogers said that if, however, Nixon felt that military considerations outweighed these political drawbacks, he should not extend the deadline beyond December 1 and should restrict herbicides to base perimeters only, excluding fields of fire.[15]

By July, two plans for giving the South Vietnamese an herbicide capability had developed within the Department of Defense. The plan favored by the Joint Chiefs would have retained six UC-123 spray aircraft in Vietnam under United States control, while giving the Vietnamese forty-three helicopter spray systems and fifteen ground spray systems. They felt that the retention of these six planes would enable the U.S. to resume large scale herbicide operations if this became necessary, but they also contemplated turning these planes over to the VNAF if orange were authorized again for use in remote areas.

Several high officials in the Department of Defense, including G. Warren Nutter (ASD/ISA), favored an alternate plan. This plan would transfer the six UC-123s to the VNAF right away for dual use as transport and spray aircraft. These officials thought that the most likely need for these spray planes would be along important lines of communication. The aircraft could spray herbicides blue or white, they said, regardless of what might be decided about orange. Nutter's group would also transfer fifteen rather than forty-three helicopter systems to the Vietnamese and only the eleven truck-mounted, eighty hand-operated, and two "Buffalo Turbine" sprayers then in Vietnam. If the South Vietnamese demonstrated a greater need, they said, the U.S. could then give them more equipment.[16]

Secretary Laird agreed with his civilian rather than his military advisors on the size and type of herbicide capability the United States would give to the South Vietnamese. On July 24, 1971, he wrote Secretary Rogers a personal letter informing him of the plan and asking for his support, or an indication of his contrary intentions. Laird said that the six UC-123s would be used along enemy infiltration routes or in border areas if the situation warranted, a position closer to that of the Joint Chiefs. He hoped the Vietnamization plan could be approved and implemented prior to December 1 to preclude another extension of the herbicide use deadline. (President Nixon, however, had not yet approved the first extension.) Laird felt " . . . this limited herbicide capability is vital to our objective of giving the South Vietnamese a reasonable opportunity to defend themselves and to determine their own future."[17]

Secretary Rogers replied that he felt the whole matter required further study. Of special concern to Rogers was the potential impact on the Geneva Protocol and pending legislation concerning Indochina. In his view:

> This proposal would likely be viewed by some in the Congress and the public as inconsistent with the President's announcement of a rapid and orderly phase-out of our use of herbicides in Southeast Asia. The fact that their use would be under the exclusive control of the South Vietnamese could be looked upon as an evasion of the President's commitment and might draw special condemnation for that reason.[18]

Secretary Rogers queried Ambassador Bunker in Saigon for his views on Laird's plan. Bunker replied on August 7 that he was against the idea. The primary risk he saw was that once the Vietnamese had their own herbicide equipment, their use of it would be outside the formal control of the United States, but "world opinion" would nevertheless hold the United States responsible for any herbicide use or misuse by the South Vietnamese. Furthermore, Bunker felt that the military value of spraying herbicides over wide areas was not clearly established. He had no indication that the South Vietnamese wanted a spray capability for use beyond base perimeters and he doubted that they would spontaneously request the U.S. to provide them with one. Also, acquiring six UC-123 spray aircraft would strain the

VNAF. Their ability to fly such planes on spray missions over enemy-controlled areas, without the heavy suppression which had supported Ranch Hand, would be questionable. Also, the VNAF was having trouble absorbing existing helicopter missions without the added burden of spray requirements. Because of these multiple problems, Bunker advised against offering the South Vietnamese any herbicide capability beyond what they already had.[19*]

Laird felt that he could not wait for the State Department's views before presenting his Vietnamization plan to President Nixon. He so informed Secretary Rogers on August 9, citing the departure from Vietnam of people knowledgeable about herbicide operations and the intense public concern over herbicides as factors justifying his haste.[20] The plan Laird submitted for Nixon's approval would have given the South Vietnamese six UC-123s capable of both spray and cargo operations in place of six regular C-123s they were already scheduled to receive, thereby avoiding the problem of absorbing more aircraft. Also, Laird wanted to give them fifteen helicopter spray systems then in the hands of U.S. forces, along with all American ground spray equipment currently in Vietnam. With this equipment, Laird wanted to provide U.S. technical training and assistance plus additional quantities of herbicides. Nixon withheld his decision, however, pending the reaction of the State Department to the plan.[21]

After a delay of more than three months after the Defense Department's original request, President Nixon on August 18 decided to extend until December 1, at the latest, permission for American forces to use herbicides around base perimeters. He ordered that this be done only by helicopters and ground spray equipment under the same restrictions applying in the United States, and then only when alternate methods were not feasible. He said that the question of providing the South Vietnamese with a herbicide capability was a separate issue, and nothing should be done or said to encourage them to acquire such a capability until he decided the matter. Nixon also hinted that the outcome of two policy reviews concerning herbicides and riot control agents might change the December 1 date.[22†] The State and Defense Departments passed word of Nixon's decision to Saigon

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* It is not clear whether during the May 1 through August 20, 1971 period the use of herbicides by U.S. forces stopped completely. Two messages from the Assistant Secretary of Defense for Public Affairs in late May authorized MACV to say that herbicides were being restricted to use around bases and in remote areas. Then, on June 30, General Abrams, after querying Washington, restated "previous guidance" to his command that all U.S. herbicide operations had been suspended on May 1 and that " . . . no, repeat no, herbicide operations are authorized." Ambassador Bunker, however, told the State Department that prior to receiving their request for comments on the early August DOD Vietnamization plan, he had been unaware that an extension of herbicide use after May 1 had not been approved.

†On January 7, 1971, Henry Kissinger at President Nixon's direction issued National Security Study Memorandum 112(NSSM 112) which directed the Department of Defense and other government agencies to examine the full range of U.S. policy options regarding riot control agents and herbicides in war in the post-Vietnam era. Then, after the Geneva Protocol became deadlocked in the Senate, Kissinger asked for another study to help in responding to a letter from Senator Fulbright on the matter.

on August 20 along with instructions to make no announcement of the extension. If specifically queried by the press, American officials were to respond that the ban on orange remained in effect and the phasing out of herbicides was continuing. The authorized response to press inquiries included nothing about an old deadline being extended or a new one being set.[23]

By August, Secretary Laird had not acted on the April 23 recommendation of the Joint Chiefs to dispose of the thousands of barrels of herbicide orange still in South Vietnam by spraying it in military operations in remote areas. On August 31, Secretary Nutter recommended giving the herbicide to the South Vietnamese, advising them of its proper uses, and letting them use it as they deemed necessary, returning any excess to the United States.[24] Dr. John S. Foster, Jr., the Director of Defense Research and Engineering, disagreed, and on September 3, he advised Secretary Laird to bring all of the orange back to the United States. Foster felt that the known impurities in orange precluded its use by the South Vietnamese.[25]

Secretary Laird agreed with Foster, and on September 13, 1971, he ordered all stocks of orange returned to the United States as quickly as practicable after the American Embassy negotiated formal transfer of title. Laird decided that all stocks of orange returned from South Vietnam or in storage at Gulfport with unacceptable levels of impurities would be incinerated, with other uses considered for the remainder.[26] On September 27, the Chairman of the JCS requested the Air Force Chief of Staff to coordinate accepting, returning to the U.S., and disposing of all herbicide orange.[27] This task would prove to be formidable because of its environmental and political ramifications.

Secretary Rogers gave his views on Vietnamization of the spray program to President Nixon on September 30, almost two months after Laird had forwarded his proposal. Unsurprisingly, Rogers disagreed with some of the key aspects of the Defense Department's plan. He opposed giving the South Vietnamese any UC-123s because they might use them for crop destruction and large area defoliation, two missions which, he claimed, lacked proven military utility and would attract criticism. And, to train VNAF spray crews, U.S. Air Force pilots would have to fly with them, violating Nixon's current guidelines. Rogers also opposed transferring the fifteen helicopter spray systems currently in use by U.S. forces. Americans might need them, and the South Vietnamese could substitute less potentially controversial ground spray devices. In any event, Rogers thought our Vietnamese allies could improvise helicopter spray systems if they needed any. Rogers did, however, favor turning over ground spray equipment and providing technical training and assistance in operating it and any improvised helicopter systems.

On the questions of additional herbicides, Rogers said that the South Vietnamese currently had a year's supply and they could obtain additional quantities on the world market. Giving them more should be disapproved or deferred until after completion of the herbicide policy review Kissinger had

directed. Rogers cautioned that the United States should only take action to Vietnamize herbicides if the South Vietnamese demonstrated a clear need and desire for such a program, and only on the condition that they return stocks of orange to American custody.[28]

In response to the requirement to use alternative means wherever possible, the MACV staff analyzed all available and conceivable possibilities for vegetation control around firebases and other installations. They concluded that herbicides needed to be used beyond the December 1 deadline. The most difficult problem, as before, was finding an alternative to herbicides for removing vegetation around mines, booby traps, and barbed wire. CINCPAC agreed with MACV and forwarded a request for extending the deadline to the Joint Chiefs on September 29. The Chiefs recognized the political problems associated with continuing herbicide use, but they said that lives had already been lost as the result of inadequate defoliation around bases in South Vietnam. They felt that saving military lives should have precedence over political considerations, and they asked Secretary Laird to obtain President Nixon's approval for U.S. forces to use herbicides around their bases as long as they were tactically committed in Vietnam.[29] Deputy Secretary Packard forwarded this request to the President on November 3.[30*]

President Nixon reached a decision on the intertwined issues of continuing herbicide use and Vietnamization on November 26. He acceded to the Defense Department's request on the former and, without a future expiration date, authorized American forces to spray herbicides from ground equipment or helicopters, subject to controls applicable in the United States, around bases where mines, booby traps, or wire ruled out other methods. However, Nixon followed the State Department's advice on Vietnamization. He said that the U.S. would not take the initiative on this question or stimulate the South Vietnamese to acquire or develop herbicide capabilities. If they did ask for help in this area, however, the U.S. could only provide ground spray equipment. UC-123 aircraft and spray systems, helicopter spray systems, and additional herbicide stocks would not be provided. Nixon said that even the ground spray equipment which Americans might give to the South Vietnamese could only be used in perimeter clearing, and any technical training and assistance would also be restricted to this limited function.[31]

Only a week after Nixon made known his decision, Secretary Laird replied with a plea for him to modify the strictures on Vietnamization somewhat. First, Laird wanted the U.S. to give the South Vietnamese the fifteen helicopter spray systems which were then in Vietnam. Second, he

*The last helicopter herbicide operation under U.S. control took place on October 31, 1971. During the period March-October 1971, thirty-one helicopter missions had sprayed 35,447 gallons of herbicides white and blue on lines of communication, base perimeters, cache sites, and landing zones.

asked Nixon to lift the prohibition against prodding them to develop an herbicide capability. Finally, he wanted the U.S. to be permitted to give the South Vietnamese future supplies of herbicides if they clearly required them. This was particularly important because of the problems associated with continuing to supply herbicides for use by U.S. forces to save American lives while denying the Vietnamese future stocks of the same chemicals to save the lives of their own soldiers.[32]

After a delay of two months, Secretary Rogers forwarded his department's views on modifying the November 26 decision. The military gains, he felt, of providing the 15 helicopter spray systems would not be worth the domestic and political costs to U.S. policies on Vietnam and the Geneva Protocol. Also, Rogers said that stocks of herbicides blue and white would last for several more months at current use rates. After explaining the domestic political considerations behind the decision to stop supplying herbicides, American officials could suggest that the South Vietnamese buy any additional quantities they needed on the open market with their own funds. This would probably not cost them more than $250,000 per year for perimeter clearing. In short, Rogers saw no need for any change to Nixon's previous decision.[33]

President Nixon resolved the Vietnamization question on February 14, 1972. He said that the U.S. would encourage the Vietnamese to establish alternate, commercial supply channels for their future herbicide needs and would provide them with more herbicides only to the extent necessary to fill their needs for perimeter clearing and spraying along important lines of communication while they were developing these alternate sources. American officials could invite the South Vietnamese to ask for the fifteen helicopter spray systems, but the Vietnamese could only have them if they agreed to use them solely for clearing base perimeters. Finally, Nixon directed that the U.S. would not stimulate the Vietnamese to acquire or develop any herbicide capabilities beyond this.[34]

The controversies and continuing questions surrounding Ranch Hand and herbicides in Southeast Asia did not end when American combat involvement in the war ceased. The Geneva Protocol remained stalled. The Nixon and Ford Administrations had to arrive at a policy governing herbicides and riot control agents in the post-Vietnam era which would find acceptance in the Senate. And, there was the problem of the 2.2 million gallons of herbicide orange in deteriorating steel drums which had to be used or destroyed. Finally, the ecological consequences and long-range health effects of the herbicide program had to be assessed, a process which still continues.

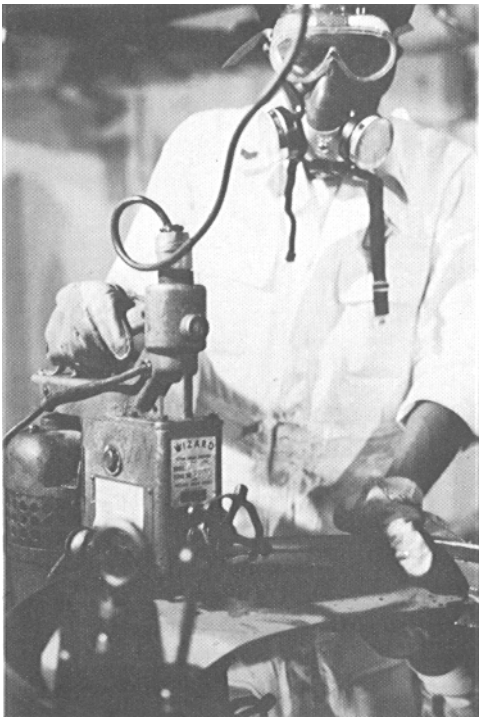
The first of these remaining questions to be resolved was devising an herbicide policy for future wars. The Geneva Protocol review Nixon had ordered in June produced an August response, through the National Security Council, which affirmed the military value of riot control agents and herbicides in various types of tactical situations. Later in the year, the Defense Department completed a more detailed analysis, which also favored these two weapons, in response to NSSM 112, an order for a study that Nixon had issued in January. In the case of herbicides, the Defense Department said that their usefulness " . . . has been conclusively established." In Vietnam, herbicides had denied concealment to the enemy, making the defense of fixed installations easier and the mounting of ambushes more difficult. These chemicals, the department believed, had " . . . saved many U.S. and allied lives."[35]

The Defense input on herbicides came from the preliminary results of a lengthy study done by the Army's Engineer Strategic Studies Group (ESSG). The ESSG based its report, released in final form in February 1972, primarily on a survey of U.S. military officers who had served in Southeast Asia. The general opinion of the officers questioned was that without defoliation, combat operations in Southeast Asia would still have been possible, but more difficult. They said that herbicides had greatly assisted observation from both the air and ground, and had played an important role in the defense of fixed bases. The main effect of crop destruction, in their opinion, had been causing the enemy to modify his operations. The Engineer Strategic Studies Group analysts also concluded that while herbicides had significance in counterinsurgency, their usefulness in conventional warfare would be more limited.[36]

The military's strong belief in the value of herbicides and riot control agents made it difficult for the Administration to reach a compromise with the Foreign Relations Committee on the Geneva Protocol as long as U.S. forces were engaged in combat in Southeast Asia or the possibility of their reinvolvement lingered. The Ford Administration broke the impasse on December 10, 1974, by informing the committee that the President intended to renounce the first use of herbicides and riot control agents in future wars except under restricted circumstances. The Foreign Relations Committee then forwarded the Protocol to the Senate by unanimous vote on December 13. On December 16, the full Senate voted to ratify by 90–0.[37]

President Gerald R. Ford set forth the future policy of the United States governing the use of herbicides and riot control agents in war in Executive Order 11850 which he signed on April 8, 1975. This order prohibited the first use of riot control agents except in defensive mode to save lives. Concerning herbicides, Ford said:

> The United States renounces, as a matter of national policy, first use of herbicides in war except use, under regulations applicable to their domestic use, for control of vegetation within U.S. bases and installations or around their immediate defensive perimeters . . .[38]



Top: "Agent Orange" emptied from drums before pumping into railway tank cars at the Naval Construction Battalion Center (NCBC), Gulfport, Miss.; bottom: "Agent Orange" prepared for transportation to the Pacific for incineration, 1977.

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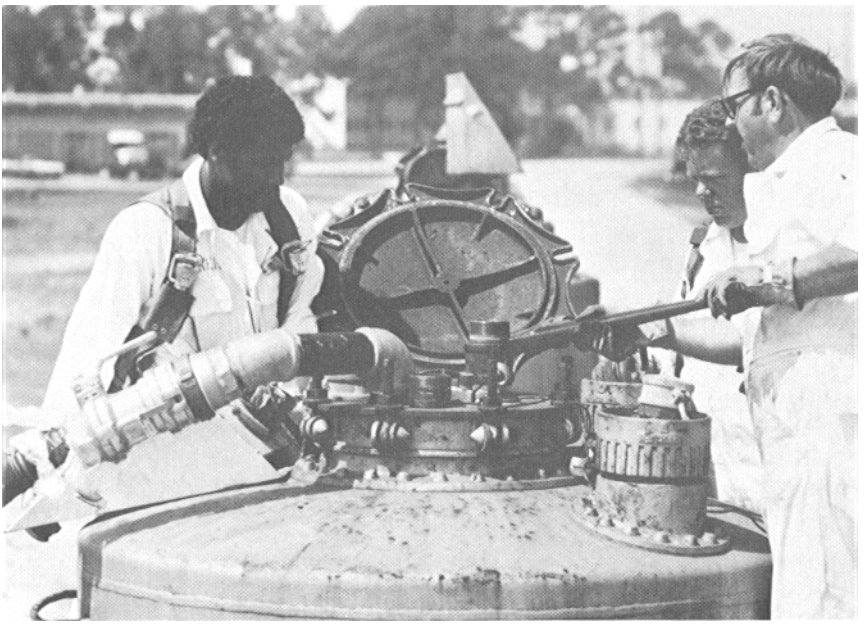
Top: defoliant storage area at the Gulfport NCBC; bottom: interior of Johnston Island bunker where the dioxin cannisters from the reprocessing operation of "Agent Orange" were stored.

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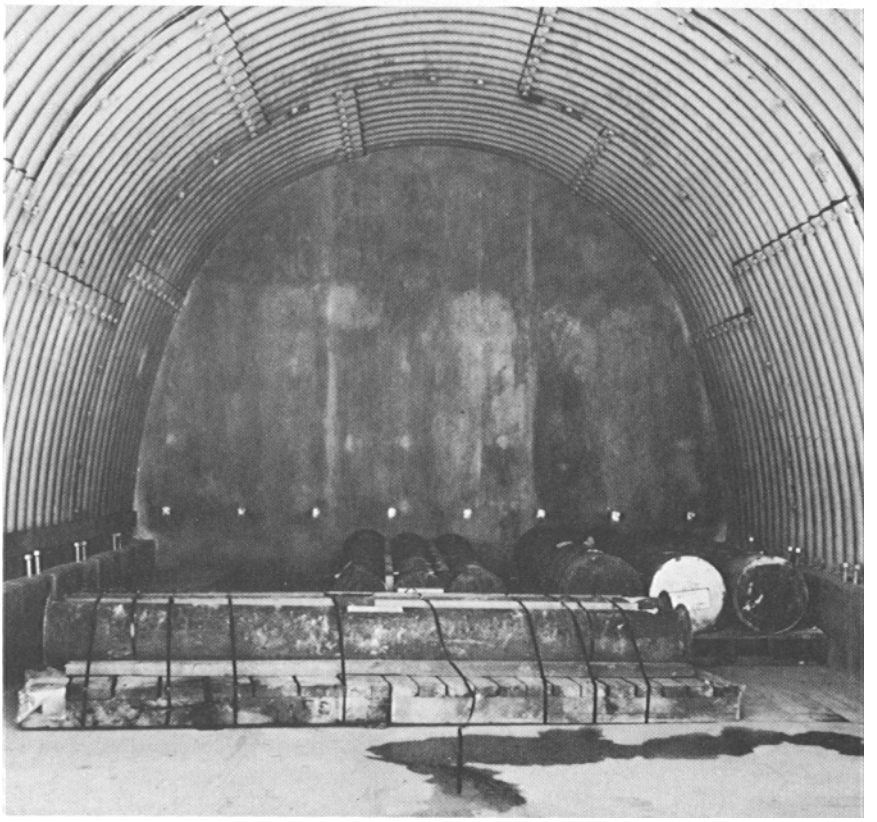


As long as this policy stands, no operation like Ranch Hand could happen again.

As Secretary Laird had ordered, the United States removed all stocks of herbicide orange from South Vietnam, an operation which ended in April 1972. The 1,370,000 gallons taken from that country were stored on isolated Johnston Island in the Pacific, while an additional 850,000 gallons remained at the Naval Construction Battalion Center (NCBC), Gulfport, Mississippi. Tests showed that the average concentration of dioxin (TCDD) was about two parts per million, for a total of about forty-four pounds of this toxic contaminant.

Between 1971 and 1974, the Air Force investigated several possible techniques for making some use of the chemical, including spraying it as it was, returning it to the manufacturers for reprocessing or resale, or employing it as a raw material in chemical manufacturing. Various methods of destruction also received consideration, such as injection in deep wells, biodegradation in soil, disposal in underground nuclear test cavities, sludge burial, microbial reduction, and high temperature incineration. Those studying the problem ruled out all of the options except destroying the herbicide by burning because of factors such as uncertainty of success, the need for further development of techniques, and lack of interest on the part of chemical companies.

In December 1974, the Air Force filed an environmental impact statement proposing burning the herbicide aboard a specially equipped ship in a remote area of the Pacific Ocean west of the Johnston Island storage site. At a public hearing in February 1975 to consider the Air Force request for a burning permit, the Environmental Protection Agency (EPA) heard testimony that techniques existed to remove excessive quantities of dioxin by reprocessing the herbicide. Accordingly, the EPA asked the Air Force to investigate this option further before proceeding with the incineration plans.

Between the fall of 1975 and July of the following year, the Air Force conducted experiments using activated charcoal to absorb dioxin from herbicide orange. The process worked, but it created the new problem of disposing of the cylinders of dioxin-laden activated charcoal. In February 1977, the Air Force concluded that the reprocessing idea had to be dropped because there was no acceptable method for dealing with the contaminated charcoal by-product.

At the request of the Air Force, the EPA reconvened a public hearing on the disposal of agent orange on April 7, 1977, and thereafter issued a permit allowing the Air Force to transport the orange at Gulfport to the North Pacific and burn it. If this operation proved successful, the EPA would give the Air Force permission to incinerate the stocks at Johnston Island also.

Under stringent safeguards and environmental monitoring procedures, Air Force personnel drained the herbicide orange from the 15,480 drums stored at Gulfport and transferred it to a Dutch-owned ship, the *Vulcanus,* which would transport it to the Pacific. The *Vulcanus* was equipped with special furnaces for burning toxic substances and had previously destroyed chlorinated hydrocarbon wastes. After agreeing to take water samples before and after the ship's passage, the Air Force obtained permission for the *Vulcanus* to transit the Panama Canal. The ship burned the Gulfport stocks between July 15 and 24, 1977. EPA, satisfied with the results, then gave the Air Force the go-ahead to incinerate the rest of the herbicide. Employees of a civilian contractor emptied the 24,795 drums of orange stored on Johnston Island, again under tight safety precautions, and the *Vulcanus* incinerated it in two loads. The last of the herbicide orange once destined for the jungles of Vietnam burned on September 3, 1977. The Air Force estimated the cost of the whole disposal operation, beginning in 1972, at over $8 million.[39]

The U.S. Congress finally mandated in a law signed by President Nixon on October 7, 1970, the extensive study, demanded by scientists, of the effects of herbicides in South Vietnam. Congress further directed the Secretary of Defense to contract with the National Academy of Sciences for this investigation.[40] On December 8, 1970, the Department of Defense signed a contract with the NAS to provide funds and other support for the study.[41] The NAS established a Committee on the Effects of Herbicides in Vietnam, chaired by Anton Lang of Michigan State University, to do the necessary research. Le Van Thoi, the President of the National Scientific Research Council of Vietnam, served as the associate chairman for liaison with Vietnamese scientists. An international group of fifteen more scientists comprised the remainder of the committee. Thirty consultants also assisted in the project.[42]

As had previous researchers, the NAS scientists found that conducting research in a country engaged in war was difficult. Much of the defoliated area was too militarily insecure to allow ground observation or sample collection, so the committee had to base its conclusions about the ecological effects of herbicides in defoliated areas largely on aerial photographs. Circumstances being far removed from a controlled scientific experiment also made separating herbicide effects from the consequences of war very difficult.

The NAS investigators failed to find any clear evidence of direct damage to human health from herbicides. However, they did discover a consistent pattern of largely second-hand reports from Montagnards claiming

that occasionally herbicides had caused acute or fatal respiratory problems in children. Because they could not visit the Montagnard areas, these reports remained unconfirmed and uninvestigated. On the controversial question of herbicide-related human birth defects, the NAS could likewise find no evidence substantiating a link in spite of making a considerable effort. However, the committee cautioned that further analysis of additional data could change this conclusion. The NAS researchers had great difficulty in assessing the psychological, social, and economic results of herbicide use on the people of South Vietnam, because the herbicide effects were relatively trivial when compared with the other effects of war and therefore almost impossible to measure separately. The president of the NAS concluded:

> On balance, the untoward effects of the herbicide program on the health of the South Vietnamese people appear to have been smaller than one might have feared.[43]

As was the case with humans, the NAS found that the effects of the herbicide spraying program on land and vegetation were also less than some scientists had suspected. The main impact of herbicides on vegetation was the immediate killing effect resulting from direct contact with the spray. Since the herbicides disappeared quickly in the soil, they had no significant effects on plants during the next growing season. The spraying program had, however, caused devastation to the mangrove forests of South Vietnam, and the NAS estimated that without a vigorous reseeding effort, these areas would not return to their prior state for perhaps a century. Almost all mangrove trees had died after just one spraying, and the committee calculated that herbicides had destroyed about 36% of all the mangrove forest areas in South Vietnam. The death of these trees would cause an eventual decline in the local woodcutting industry and had reduced the habitat of some important types of animal life.

Most of the herbicide had been sprayed, however, over South Vietnam's inland forests, and the NAS committee engaged in much internal and external controversy while trying to reach some conclusions about the extent to which the chemicals had damaged these forests. About 10.3% of the area had received one or more herbicide treatments, and the NAS committee estimated (not unanimously, however) that the spray had killed somewhere between about 6% and 24% of the "merchantable timber" growing in this area. Two-thirds of the treated inland forest had received only one application of herbicide, and the NAS estimated that few trees died from these single doses. In the dense forests, such areas should recover on their own. However, the NAS felt that forest sprayed three or more times, about 12% of the total sprayed, would need a large degree of human assistance to recover to its original condition. In some areas, stands of bamboo had increased, but the NAS committee could find no evidence of the rapid invasion of bamboo into new forest areas as a result of herbicides. Their studies also showed that herbicides had not had any lasting harmful

effects on the amount of nutrients in soil, with the possible exception of potassium. By way of comparison, the NAS noted that bombing and shelling may have had a worse effect on inland forests. Besides those trees killed immediately, bomb and shell fragments imbedded themselves in others, making future attempts to saw them into lumber both costly and hazardous.[44]

Regardless of the conclusions of the NAS Report, concern over the health effects of exposure to herbicides, especially over the long term, lingered and reappeared. On March 22, 1978, WBBM in Chicago aired a television news report which publicized an allegation that forty-one veterans of the Vietnamese conflict then living in the Midwest were suffering adverse effects from exposure to agent orange. A benefits counselor working at the Veterans Administration office in Chicago had first suggested the problem because of similarities in the background of veterans coming to her office with medical complaints. The complaints listed by this group included diminished sex drives, psychological problems, numbness, and skin rashes.[45]

During the month following the WBBM story, the Air Force Surgeon General directed the USAF Occupational and Environmental Health Laboratory (OEHL) at Brooks AFB, Texas, to update previous assessments of human health effects from exposure to herbicides, agent orange in particular. The OEHL published its report, authored by four Air Force officers, in October 1978. This report was basically a review of existing scientific literature on the subjects listed in its title: "The Toxicology, Environmental Fate, and Human Risk of Herbicide Orange and its Associated Dioxin." Since their work was done four years after the NAS study, the OEHL analysts benefited from additional research which had been done during the intervening years. One category of information they examined came from episodes of known or suspected human contact with 2,4,5-T and dioxin, such as one that occurred after a chemical plant accident at Seveso, Italy, in 1976. Their review of published research showed that reports of 2,4,5-T toxicity, and therefore TCDD toxicity, were minimal considering the degree of use. The use of 2,4-D and 2,4,5-T worldwide since the middle 1940s, with minimal reports of adverse effects, indicated to the report's authors that they are generally safe chemicals if used properly. They found that large doses of 2,4-D have been given to humans in controlled circumstances without adverse effects. However, if the dose were significantly high, they found that a number of organ systems might be affected, including the skin, liver, and central and peripheral nervous systems. Also, according to their research, any adverse effects of 2,4-D and 2,4,5-T should manifest themselves shortly after exposure. The Air Force researchers concluded that symptoms arising for the first time months to years after the last exposure were probably due to an etiology other than 2,4-D and 2,4,5-T. Also, although no research could confirm cancer, fetal deformities or mutations caused by exposure to phenoxy herbicides or dioxin, the report indicated that the topic remained open.[46]

Media interest in this subject continued in the months following the WBBM report, and various groups began to press the Veterans Administration and other government agencies to take some kind of action. President Jimmy Carter became an object of this pressure on May 30, 1979, when one member of a group of Vietnam veterans at a White House meeting shouted at him, "What are you doing about agent orange? Thousands of men are dying! We need an epidemiological study done on the Vietnam veteran."[47]

On June 4, 1979, the Air Force announced it would conduct a lengthy study of the health of 1,200 Ranch Hand veterans, a study which had been in the planning stages for several months. The research plan as announced was to compare the health of Ranch Hand veterans with a control group of similar men to determine whether there were any detrimental health effects from exposure to herbicide orange. The Air Force decided to focus on Ranch Hand veterans because they were the most likely group of those who served in Southeast Asia to have had significant exposure to herbicides. The Air Force announced that the study would take a minimum of six years so as to give any long term health problems time to emerge. Until the long term health effects, if any, of the Ranch Hand spray missions are determined, the story of this operation will remain incomplete.[48]

Appendices

Appendix 1
Characteristics of Herbicides Used in Southeast Asia

The chemicals present in the defoliant mixes employed by the United States Air Force in Southeast Asia were developed originally to control weeds, that is, plants growing in places where man does not want them to be. Weeds present serious problems to agriculture because they compete with crops for available sunlight, moisture, and nutrients. For millenia the only weapons farmers had to use against weeds were mechanical, such as the hoe and plow. In 1896 the modern use of chemicals to control weeds began with the work of a French scientist named Bonnet. He observed that the seedlings of wild mustard, a common weed in Western Europe, died when sprayed with a fungicide developed for use on grape vines. Bonnet later found that copper sulfate, a component of the fungicide, would selectively kill the wild mustard growing in a cereal crop. Other research showed that chemical compounds such as sodium nitrate, ferrous sulfate, and dilute sulfuric acid also acted as selective herbicides against broad-leafed weeds in fields of cereal plants with narrow, upright leaves. These compounds were dessicants and worked by extracting water from plant tissues. Their selectivity depended on the broad, level surfaces of the weeds collecting more of the chemical spray or dust than cereal leaves. The performance of these chemicals, except for dilute sulfuric acid, was, however, erratic.

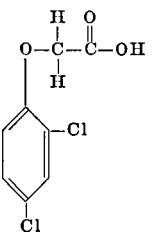
Synthetic plant hormones or plant growth regulators, precursors of the primary herbicides used in Vietnam, were discovered in the 1930s. The first synthetic plant hormone herbicides were quite expensive and therefore impractical as agricultural chemicals. A search undertaken to find less expensive and more active artificial plant hormones in 1942 identified 2,4-dichlorophenoxyacetic acid (2,4-D) as one of the most promising. Field trials during the World War II years provided that a related compound, 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) could also be used as a selective herbicide. These two compounds later became important agricultural chemicals, and they were primary components of several of the herbicides employed in the Ranch Hand program.[1]

Three terms used throughout this study need to be defined: "herbicide," "defoliant," and "dessicant." An herbicide is a chemical which will kill or injure a plant when applied to air, soil, water, or the plant itself. The defining characteristic of defoliants is that they cause the leaves of a plant to fall prematurely, although the plant may or may not die as a result. A dessicant is a drying agent which causes a plant's tissues to lose their moisture,

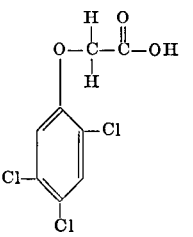
thereby killing or damaging the plant. The use of a dessicant may or may not result in subsequent defoliation. Thus, a given chemical may fall into one or more of these categories. Two of the terms, "herbicide" and "defoliant" are used practically interchangeably in discussions about the Ranch Hand program, but sometimes the differences in meaning may be important.[2]

None of the herbicides used in Southeast Asia were of a new or experimental nature. They had all been used for several years in commercial agriculture both in the United States and in other countries. By way of illustration, in 1961, the year before the Ranch Hand program began, about 40 million acres plus hundreds of thousands of miles of roadsides, railroads, and utility rights of way were treated with phenoxy herbicides in the United States. Of this total, more than ten million acres, an area about one-fourth the size of South Vietnam, received aerial spray applications. The herbicides used in Southeast Asia were familiar agricultural chemicals, and aerial spraying of them was common.[3]

2, 4-D



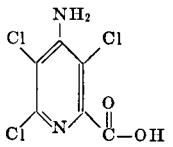
2, 4, 5-T



The compounds 2,4-D and 2,4,5-T are chlorinated phenoxy acids, and herbicides contain them in the acid form, as salts, and as esters. Which form is chosen for a specific application depends on desired characteristics such as solubility, volatility, and melting point. The persistence of 2,4-D and 2,4,5-T in soil is limited to only a few weeks, and high dosages are necessary to produce any overt effects in humans. However, considerable concern has developed over the potential danger from 2,3,7,8-tetrachlorodibenzo-paradioxin, commonly known as dioxin, an impurity present in 2,4,5-T.

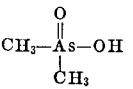
Phenoxy herbicides are growth regulators which have extensive effects on the structure of plants. Their action is generally rapid, and the fact that they may spread throughout a plant allows them to affect almost all of its biological activities. A plant's reaction to 2,4-D or 2,4,5-T may result in an abnormal production of buds or roots and the excessive growth of tissues. In lesser concentrations, the growth in tissues surrounding a plant's vascular system and the resultant restriction in the flow of nutrients may cause a slow death of the plant. In short, these two herbicides stimulate a proliferation of tissues.[4]

Picloram



A third compound used in the Ranch Hand herbicide formulations was picloram. Solid commercially as Tordon, it has the formal chemical name of 4-amino-3,5,6-trichloropicolinic acid. In its pure state, it is a white powder with a smell like chlorine. Picloram's toxicity to man is thought to be lower than that of 2,4-D or 2,4,5-T. Like the phenoxy herbicides, picloram regulates plant growth, but the precise mechanisms involved are not known. It is an extremely mobile compound, being readily absorbed by both the leaves and roots and transported throughout the plant's tissues. Its mobility enhances its effectiveness against woody plants. Some of the effects of picloram are to stunt leaves and cause terminal growth to stop. Also, tissues along the stem proliferate, and the stem tends to bend and split. Roots may deteriorate, and the plant soon dies. Compared to 2,4-D, picloram is much more mobile, better able to penetrate roots, and more toxic to plants. One important difference between picloram and the phenoxy herbicides is that it is persistent in soils whereas the phenoxy compounds generally are not. Its persistence allows it to be used as a general soil sterilant under some conditions.[5]

Cacodylic Acid



Cacodylic acid, formally known as hydroxydimethylarsine oxide and sold as Phytar, is not a plant growth regulator like the other three herbicides. Rather, it functions as an "uncoupler," keeping the plant from using the products of its metabolism for growth and tissue maintenance. It is thought that the effectiveness of cacodylic acid, like other arsenic compounds used as herbicides, derives from its ability to substitute arsenic for phosphorus in biochemical reactions. Its effects on a plant are to stop growth, attack membrane integrity, and cause drying, yellowing, and, eventually, death. Because drying is its primary observable effect, cacodylic acid is often labeled as a dessicant. It is a contact herbicide and is rapidly rendered ineffective in soil. Cacodylic acid, an organic compound, can replace the highly toxic inorganic forms of arsenic such as sodium arsenite and sodium arsenate in an herbicide role. These inorganic arsenic compounds are very toxic to both man and animals and can cause accidental fatalities. Cacodylic acid itself is only slightly toxic to humans, with a probable lethal

oral dose of one ounce or more, and it has little or no toxicity when applied to the skin.[6]

Combinations of these four herbicides were used to formulate the different color-coded agents used in the Ranch Hand operation in Southeast Asia. Appendix 2, Table 1 lists the composition of these mixtures.

Appendix 2
Summary of Herbicide Operations

TABLE 1.—MAJOR HERBICIDE MIXTURES USED IN VIETNAM

*Military Color Code or Trade Name**	*Composition (active ingredients)*
Pink	60% n-butyl ester of 2,4,5-T
	40% isobutyl ester of 2,4,5-T
Green	100% n-butyl ester of 2,4,5-T
Pink-Green mixture	80% n-butyl ester of 2,4,5-T
	20% isobutyl ester of 2,4,5-T
Dinoxol	50% butyoxyethanol ester of 2,4-D
	50% butyoxyethanol ester of 2,4,5-T
Trinoxol	100% butyoxyethanol ester of 2,4,5-T
Purple	50% n-butyl ester of 2,4-D
	30% n-butyl ester of 2,4,5-T
	20% isobutyl ester of 2,4,5-T
Blue	100% sodium salt of cacodylic acid
Orange	50% n-butyl ester of 2,4-D
	50% n-butyl ester of 2,4,5-T
Orange II	50% n-butyl ester of 2,4-D
	50% isooctyl ester of 2,4,5-T
White	80% triisopropanolamine salt of 2,4-D
	20% triisopropanolamine salt of picloram

Source: The Committee on the Effects of Herbicides in Vietnam, National Research Council, *The Effects of Herbicides in South Vietnam: Part A* (Washington, D.C.: National Academy of Sciences, 1974), p II-4; rprt, Review and Evaluation of ARPA "Defoliation" Program in South Vietnam [1962], pp 31-32; rprt, Capt. Alvin L. Young, *et al*, USAF Occupational and Environmental Health Laboratory, The Toxicology, Environmental Fate, and Human Risk of Herbicide Orange and Its Associated Dioxin, Oct. 78, p I-7 (hereafter cited as USAF OEHL Report).

*Herbicide drums were identified by a four-inch-wide circular band of paint colored in correspondence with these color codes.

TABLE 2.—HERBICIDE DISSEMINATED IN SOUTH VIETNAM JAN 1962-DEC 1964

Military Herbicide	*Gallons of Formulation*	*Pounds Active Ingredient*
Blue	5,200	10,000
Green	8,208	66,980
Pink	122,792	1,001,980
Purple	145,000	1,180,300
Total	281,200	2,259,260

Source: USAF OEHL Report, p I-9.

TABLE 3.—HERBICIDE DISSEMINATED (GALLONS) IN SOUTH VIETNAM JAN 1965–FEB 1971

Military Herbicide	*Craig, 1974*[1]	*NAS Report, 1974*[2]	*Westing, 1976*[3]
Orange	10,645,904	11,266,929	11,712,860
White	5,632,904	5,274,129	5,239,853
Blue	1,144,746	1,137,470	2,161,456
Total	17,423,554	18,936,068	19,114,169

1. Craig, D. A. 1975. Use of Herbicides in Southeast Asia. Historical Report. San Antonio Air Logistics Center, Directorate of Energy Management, Kelly AFB, Texas.

2. Committee on the Effects of Herbicides in South Vietnam. 1974. *Part A. Summary and conclusions.* National Academy of Science, Washington, D.C.

3. Westing, A. H. 1976. *Ecological consequences of the second Indochina War.* Stockholm International Peace Reasearch Institute. Almgrist and Wiksel Internation, Stockholm, Sweden. Westing's data covers 1962–1971.

Source: USAF OEHL Report, p. I-10.

TABLE 4.—ACRES TREATED IN SOUTH VIETNAM JAN 1962–FEB 1971*

	Acres Treated			
Year	*NAS Report*[1]	*Irish et al.*[2]	Westing[3]	*Mean*
1962	NA[a]	5,681	5,724	5,703
1963	NA	24,947	24,920	24,934
1964	NA	93,842	93,869	93,856
1965	75,501[b]	221,559	221,552	221,555
1966	608,106	842,764	845,263	765,378
1967	1,570,114	1,707,758	1,707,784	1,661,885
1968	1,365,479	1,330,836	1,696,337	1,464,217
1969	1,365,754	NA	1,519,606	1,442,680
1970	294,925	NA	252,989	273,982
1971	1,259	NA	3,346	2,303
			Total of Mean =	5,956,493

*Comparison from three sources. No allowance for multiple coverage.

[a]Data not available (NA).

[b]Data for period August 65 through December 65.

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2. Irish, K. R., R. A. Darrow and C. E. Minarik. 1969. *Information manual for vegetation control in Southeast Asia.* Miscl. Public. 33. Department of the Army, Fort Detrick, Frederick, Maryland.

3. Westing, A. H. 1976. *Ecological consequences of the second Indochina War.* Stockholm International Peace Research Institute. Almgrist and Wiksel Internation, Stockholm, Sweden. Westing's data cover 1962–1971.

Source: USAF OEHL Report, p. I-12.

TABLE 5.—HERBICIDE OPERATIONS IN LAOS

Date	*Project Number*	*Area Sprayed in Hectares**	*Gallons Dispensed*	*Herbicide*
Dec 1965	20W	6,120	41,050	Orange
Jan 1966	20W	9,255	59,400	Orange
Feb 1966	20W	9,590	62,150	Orange
Mar 1966	20W	4,855	29,300	Orange
Apr 1966	20W	3,360	21,700	Orange
May 1966	20W	3,560	23,000	Orange
Jun 1966	20W	3,515	12,700	Orange
Jul 1966	20W	4,010	26,000	Orange
Aug 1966	20W	3,425	22,100	Orange
Sep 1966	20W	620	4,000	Orange
	2W	1,180	7,600	Orange
Oct 1966	20W	1,400	9,000	White
	2W	700	4,500	White
Nov 1966	20W	2,910	20,010	White
	20W	600	3,600	Orange
Dec 1966	20W	2,100	12,600	White
Jan 1967	20W	1,500	9,000	White
	20W	1,700	10,300	Orange
Feb 1967	20W	1,500	9,000	Orange
Mar 1967	20W	450	2,790	Orange
Oct 1968	—	720	6,000	Orange
Nov 1968	—	960	8,000	Blue
Dec 1968	—	360	2,700	Orange
Feb 1969	—	840	7,000	Orange
Sep 1969	—	762	6,350	Blue

*Note: 2.471 acres = 1 hectare

Source: 1971 CHECO Report, p. 106

Appendix 3
Ranch Hand Organizational Designations

Special Aerial Spray Flight—TDY from TAC, November 1961–July 1964

Special Aerial Spray Flight—subordinate to the 315th Troop Carrier Group, later the 315th Air Commando Group, July 1964–October 15, 1966

12th Air Commando Squadron—October 15, 1966–August 1, 1968

12th Special Operations Squadron—August 1, 1968–July 31, 1970

A Flight, 310th Tactical Airlift Squadron—July 31, 1970–January 28, 1971

Appendix 4
Key Leaders

SECRETARIES OF THE AIR FORCE

Eugene M. Zuckert	24 Jan 1961 -30 Sep 1965
Harold Brown	1 Oct 1965 -14 Feb 1969
Robert C. Seamans, Jr.	15 Feb 1969 -14 May 1973
John L. McLucas (Act)	15 May 1973-18 Jul 1973
John L. McLucas	19 Jul 1973 -23 Nov 1975

CHIEFS OF STAFF OF THE AIR FORCE

Gen. Curtis E. LeMay	30 Jun 1961 -31 Jan 1965
Gen. John P. McConnell	1 Feb 1965 -31 Jul 1969
Gen. John D. Ryan	1 Aug 1969-31 Jul 1973
Gen. George S. Brown	1 Aug 1973-30 Jun 1974
Gen. David C. Jones	1 Jul 1974 -21 Jun 1978

COMMANDERS IN CHIEF, PACIFIC

ADM Harry D. Felt	31 Jul 1958 -30 Jun 1964
ADM Ulysses S. G. Sharp	30 Jun 1964-31 Jul 1968
ADM John S. McCain, Jr.	31 Jul 1968 - 1 Sep 1972

COMMANDERS IN CHIEF, PACIFIC AIR FORCES

Lt. Gen. Emmett O'Donnell, Jr.	1 Aug 1959-31 Jul 1963
Gen. Jacob E. Smart	1 Aug 1963-31 Jul 1964
Gen. Hunter Harris, Jr.	1 Aug 1964-31 Jan 1967
Gen. John D. Ryan	1 Feb 1967 -31 Jul 1968
Gen. Joseph J. Nazzaro	1 Aug 1968-31 Jul 1971
Gen. Lucius D. Clay, Jr.	1 Aug 1971-30 Sep 1973
Gen. John W. Vogt, Jr.	1 Oct 1973 -30 Jun 1974

COMMANDERS, SEVENTH AIR FORCE

Organized at Tan Son Nhut, 1 April 1966. Replaced 2d Air Division

Lt. Gen. Joseph H. Moore	1 Apr 1966-30 Jun 1966
Gen. William W. Momyer	1 Jul 1966 -31 Jul 1968
Gen. George S. Brown	1 Aug 1968-31 Aug 1970
Gen. Lucius D. Clay, Jr.	1 Sep 1970 -31 Jul 1971
Gen. John D. Lavelle	1 Aug 1971- 6 Apr 1972
Gen. John W. Vogt, Jr.	7 Apr 1972-30 Sep 1973

DIVISION, COMMANDERS

2d ADVON

Established by Thirteenth Air Force on 15 November 1961 with four numbered detachments, three located in South Vietnam, and one in Thailand. Inactivated October 1962; replaced by 2d Air Division.

Brig. Gen. Rollen H. Anthis 15 Nov 1961- 8 Oct 1962

2d AIR DIVISION

Organized 8 October 1962. Discontinued 1 April 1966; replaced by Seventh Air Force

Brig. Gen. Rollen H. Anthis*	8 Oct 1962 - 1 Dec 1962
Col. Harvey N. Brown (Interim)	2 Dec 1962 -unk
Brig. Gen. Robert R. Rowland	Dec 1962 -19 Dec 1963
Brig. Gen. Milton B. Adams	20 Dec 1963 -20 Jan 1964
Lt. Gen. Joseph H. Moore	21 Jan 1964 -31 Mar 1966

*Anthis also wore a second hat as Chief, Air Force Section, MAAG, Vietnam.

Notes

Chapter I

The Development of a Military Herbicide Capability

1. Eldon W. Downs and George F. Lemmer, "Origins of Aerial Crop Dusting," *Agricultural History,* Vol 39, No 3 (Jul 1965), pp 123-135.

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3. Edward J. Neil, "Gas Stopped Ethiopians: War Correspondent Tells How Airman Burned Enemies' Feet," Associated Press dispatch, 1936, quoted in rprt, "Use of Gas in Ethiopia—1936," Chemical Warfare School, Edgewood Arsenal, MD, undated, pp 1-3.

4. "Selassie Speaks," *Time,* Jul 13, 1936, quoted in rprt, "Use of Gas in Ethiopia—1936," p 6.

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6. Rprt, Army Air Forces Board, Orlando, FL, "Marking and Defoliation of Tropical Vegetation," Dec 18, 1944.

7. Royal Air Force, *The Malayan Emergency, 1948-1960,* (London: Ministry of Defence, Jun 1970), pp 113-114, 152; U.S. Aerospace Studies Institute, *The Accomplishments of Airpower in the Malayan Emergency (1948-1960),* (Maxwell AFB, AL: Air University, May 1963), p 57.

8. Rprt, Wright Air Development Center, Wright-Patterson AFB, OH, subj: Engineering Study on a Large Capacity Spray System Installation for Aircraft, Jun 3, 1952.

9. *Ibid.*

10. Technical Study, Kent Irish, Dep Commander, Scientific Activities, Biological Warfare Laboratories, Fort Detrick, MD, "Anticrop Agent Munition Systems," Jul 1958; Dorothy L. Miller, *History of Air Force Participation in the Biological Warfare Program, 1951-1954,* (Historical Division, Air Materiel Command, 1957), pp 117-120.

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12. John I. Lumpkin and Mary J. Konopnicki, *Military Aerial Spray Operations, 1946-1960,* (HQ TAC Historical Division, *ca* 1961).

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Chapter II

The Decision to Send Spray-Equipped C-123s to South Vietnam

1. For a detailed discussion of the Kennedy Administration's decision to intervene in South Vietnam, see *United States-Vietnam Relations 1945-1967* (Washington: U.S. Government Printing Office, 1971), Books 2 (IV.B.1), 11 and 12, from which much of this account has been extracted.

2. Memo, Wa.t W. Rostow to the President, no subj, Apr. 12, 1961.

3. Memo, Task Force Draft for the President, subj: A Program of Action to Prevent Communist Domination of South Vietnam, Apr 26, 1961.

4. Ltr, Pres John F. Kennedy to Pres Ngo Dinh Diem, May 8, 1961.

5. NSAM No 52, May 11, 1961.

6. *Ibid.*; memo, Task Force Draft, subj: A Program of Action to Prevent Communist Domination of South Vietnam, pp 4-5.

7. Ltr, Pres Ngo Dinh Diem to Pres John F. Kennedy, May 15, 1961.

8. Ltr, Brig Gen Edward G. Lansdale, Asst SECDEF, to Dir/Defense Research and Engineering (DDR&E), subj: Combat Development and Test Center, Vietnam, May 16, 1961.

9. JCS 2343/3, Status Report on the Presidential Program for Vietnam as of July 10, 1961, Jul 21, 1961.

10. JCS 2343/12, Status Report on the

Presidential Program for Vietnam as of July 21, 1961, Aug 15, 1961. In both of these status reports, paragraph number 20 described activities of the CDTC, including defoliation. Later, defoliation to remove jungle cover came to be known as CDTC Task Number 20, and "20" was often used in the designation of defoliation projects.

11. Rprt, Review and Evaluation of ARPA/OSD "Defoliation" Program in South Vietnam, (1962), App A: Target Evaluation Data, p 1; rprt, author not indicated, subj: Herbicide Operations in the Republic of Vietnam, (1965), Supporting Document #1 of CHECO Report, *Herbicide Operations in Southeast Asia July 1961-June 1967,* p 2; rprt, Dr J. W. Brown, U.S. Army Chemical Corps Biological Laboratories, Fort Detrick, MD, subj: Vegetational Spray Tests in South Vietnam, Apr 1962, pp 9, 10, 39-46. Nine tests of spraying herbicides from the air took place in South Vietnam before the Ranch Hand planes arrived. Seven involved a C-47; one, an AD-6 fighter plane; and one, an H-34 helicopter. See Brown, above, pp 39-45.

12. American advisors found out in the summer of 1961 that the VNAF was using napalm, rockets, and 20-mm guns against rice paddies in an attempt to deny rice to the Viet Cong. This use of ordnance was so unsuccessful that the advisors were able to persuade the VNAF to abandon this tactic. See Reference Book for the Meeting with the Secretary of Defense, Oct. 8, 1962.

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14. Memo, U. Alexis Johnson, subj: Concept for Intervention in Vietnam, Oct 10, 1961, with two supplemental notes dated Oct 11, 1961.

15. The GPO edition of the *Pentagon Papers* (cited earlier) on page 79 of Section IV.B.1 (Book 2) describes the U. Alexis Johnson paper as listing only two "Specific Actions to be Taken Now" concerning Vietnam, neither of which has to do with defoliants. However, the Johnson paper itself lists on pages 7 and 8 five different "Specific Actions to be Taken Now," three of which, including the defoliation proposal, relate specifically to South Vietnam.

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17. Msg, DEPTEL 337, Sep 23, 1961, cited in JCS 2343/197, Feb 14, 1963, p 10.

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22. Memo, Gen L. L. Lemnitzer to Gen Taylor, subj: Counterinsurgency Operations in South Vietnam, Oct 12, 1961.

23. Memo, Sec Robert S. McNamara to SAF and CJCS, subj: Chemical Defoliant, Spraying Equipment and Aircraft, Vietnam, Nov 7, 1961.

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25. Memo, Dep SECDEF to the President, subj: Defoliation Operations in Vietnam, Nov 21, 1961.

26. Memo, SECSTATE to the President, subj: Defoliant Operations in Vietnam, Nov 24, 1961.

27. NSAM No 115, subj: Defoliant Operations in Vietnam, Nov 30, 1961.

28. NSAM No 111, subj: First Phase of Vietnam Program, Nov 22, 1961.

Chapter III

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2. Capt George T. Adams, *TAC Aerial Spray Flight Operations in Southeast Asia, 1961-1964* (TAC/SASF, undated), pp 1-3 (hereafter cited as Adams monograph); int-

vw, author with Lt Col Carl W. Marshall, USAF (Ret.), May 9, 1977 (hereafter cited as Marshall intvw).

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4. Marshall intvw.

5. Hagerty intvw; intvw, author with Maj Marcus B. Keene, Jr., USAF (Ret.), May 10, 1977 (hereafter cited as Keene intvw).

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7. Marhsall intvw; Keene intvw; photo, USAF #111537, Dec 1, 1961.

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35. Hagerty intvw.

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37. Hagerty intvw; Keene intvw.

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49. Memo, SECDEF to the President, subj: Defoliant Operations in Vietnam, Feb 2, 1962.

50. Memo, Bromley Smith, Exec Sec, NSC, to SECDEF, Feb 5, 1962.

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Chapter IV

Early Evaluations and Expanded Operations

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3. Msg, ADMINO CINCPAC to CHMAAGV, subj: Defoliant Operations 130349Z Feb 62.

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7. Keene intvw; SECDEF Book for Mar 1962 Mtg, Tab C, subj: Ranch Hand Defoliant Operations, *ca.* Mar 1962.

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9. Rprt, Dr James W. Brown, Dep Chief, Crops Division, U.S. Army Chemical Corps Biological Laboratories, Fort Detrick, MD subj: Preliminary Report of Vegetational Spray Tests, Mar 8, 1962, p 2.

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12. Msg, COMUSMACV to CINCPAC,

231045Z Mar 62.

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20. Ltr, Maj Gen R. G. Weede, CS MACV, to CINCPAC, subj: Operational Evaluation-Defoliation, Jun 9, 1962.

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26. Msg, PACAF to TAC, subj: Retention of Ranch Hand C-123, 150300Z Mar 62.

27. Msg, TAC to CSAF, subj: Ranch Hand, 202105Z Mar 62.

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29. Msg, 2d ADVON to 13 AF, 311155Z Mar 62.

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32. Msg, PACAF to TAC, subj: Rotation of Ranch Hand Aircraft, 242020Z Apr 62.

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37. Msg, COMUSMACV to CINCPAC, 130255Z Jun 62; msg, COMUSMACV to CINCPAC, subj: Defoliation, 140137Z Jul 62.

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43. NSAM No 178, McGeorge Bundy to SECSTATE and SECDEF, subj: Destruction of Mangrove Swamps in South Vietnam, Aug 9, 1962.

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Chapter IX

Ranch Hand Ends Its Work

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Chapter X

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Glossary

A/A45Y-1	The herbicide spraying system first installed in Ranch Hand aircraft in 1964
A-1	The piston and propeller driven, single-engine, tail-wheel fighter plane known as the Douglas "Skyraider".
A-4	A U.S. Navy jet fighter
AAAS	American Association for the Advancement of Science
ACS	Air Commando Squadron
ACW	Air Commando Wing
AD-6	The A-1H fighter plane (a designation used early in the Vietnam war)
AFGP	Air Force Advisory Group
AID	Agency for International Development (also USAID)
AMEMBASSY	American Embassy
ARPA	Advanced Research Projects Agency (under DOD)
ARVN	Army of the Republic of Vietnam (South Vietnam)
ASD/SA	Assistant Secretary of Defense for Systems Analysis
B-52	An eight-engine, heavy, jet bomber
B-57	A twin-engine, medium, jet bomber
C-47	The military version of the Douglas DC-3 twin-engine, piston and propeller driven tail-wheel, transport aircraft
C-54	A four-engine, piston and propeller driven, transport aircraft (the military version of the DC-4)
C-118	A four-engine, piston and propeller driven, transport aircraft (the military version of the DC-6)
C-119	A medium sized twin-engine, piston and propeller driven, transport aircraft known as the "Flying Boxcar"
C-123B	The Fairchild "Provider" twin-engine, piston and propeller driven, transport aircraft used by the Air Force to spray herbicides in Southeast Asia (see also UC-123)
C-123K	The modified version of the C-123 which had two jet engines in addition to its two piston engines
C-124	A large, four-engine, piston and propeller driven, transport aircraft
C-130	A four-engine, turboprop, transport aircraft known as the "Hercules"
Cacodylic Acid	Hydroxydimethylarsine oxide, organic arsenic compound which was the major component of herbicide blue
CBR	Chemical, biological and radiological weapons
CBU	Cluster bomb unit

CDTC	Combat Development and Test Center
CHMAAGV	Chief of the Military Assistance Advisory Group, Vietnam
CIC	Commander in Chief
CICV	Combined Intelligence Center, Vietnam
CINCPAC	Commander in Chief, Pacific—the commander of all U.S. forces in the Pacific, including Southeast Asia
CINCPACAF	Commander in Chief, Pacific Air Forces
CINCUSARPAC	Commander in Chief, United States Army, Pacific
CJCS	Chairman of the Joint Chiefs of Staff
CM	Memorandum (CJCS)
COC	Combat Operations Center
COMUSMACV	Commander, U.S. Military Assistance Command, Vietnam
CONUS	Continental United States
CS	Chief of Staff
CSAF	Chief of Staff of the U.S. Air Force
CY	Calendar Year
Defoliant	A chemical which causes plants to shed their leaves
DEPTEL	Department (of State) telegram
DDR&E	Director of Defense Research and Engineering
DMZ	The Demilitarized Zone separating North and South Vietnam
DOD	Department of Defense
Dessicant	A drying agent
Dioxin	2,3,7,8 tetrachlorodibenzo-para-dioxin (also abbreviated TCDD), a very poisonous impurity created in the manufacturing process of 2,4,5-T which was present in small amounts in herbicides purple and orange. "Dioxin" is a generic name applicable to a number of substances, but in this study, it is used as a synonym for TCDD.
DRV	Democratic Republic of Vietnam (North Vietnam)
EMBTEL	Embassy telegram
EOTR	End-of-tour report
EPA	Environmental Protection Agency
ESSG	Engineer Strategic Studies Group
F-4	A twin-engine, jet fighter plane called the "Phantom II"
F-5	A small, twin-engine, jet fighter aircraft
F-100	A single-engine, jet fighter called the "Super Sabre"
FAC	Forward Air Controller

Farm Gate	Code name for a U.S. Air Force program which began in 1961 to train VNAF fighter pilots and (clandestinely) to fly combat missions for the VNAF. The "Farm Gate Concept" refers to the practice of U.S. personnel flying missions in aircraft carrying South Vietnamese markings and ostensibly under South Vietnamese control.
FY	Fiscal Year—U.S. government fiscal years governing DOD appropriations during the period covered by this study began on July 1 of the previous calendar year and ran through June 30. For example, FY 67 covered the period from July 1, 1966 through June 30, 1967.
Geneva Protocol	The Geneva Protocol of 1925 which prohibited the use in warfare of chemical and biological weapons
GVN	Government of (South) Vietnam
H-34	A piston engine helicopter
HAC	Herbicide Assessment Commission of the American Association for the Advancement of Science
Hectare	10,000 square meters, or about 2.47 acres
Herbicide	A chemical which injures or kills plants
Hist	History
ICC	International Control Commission—the body which supervised the observance of the 1954 Geneva accords
ISA	The office of the Assistant Secretary of Defense for International Security Affairs
J-1	The personnel staff of a joint command such as MACV or the JCS
J-2	The intelligence staff of a joint command such as MACV or the JCS
J-3	The operations staff of a joint command such as MACV or the JCS. Subordinate staff elements under the J-3 of MACV had designation numbers like J32 or J325.
J-4	The logistics staff of a joint command such as MACV or the JCS
J-5	The plans staff of a joint command such as MACV or the JCS
JCS	Joint Chiefs of Staff—the military commanders of the U.S. armed forces who together constitute the highest point in the military chain of command
JCSM	JCS Memorandum
JGS	Joint General Staff—the South Vietnamese supreme military command
JOC	Joint Operations Center
JP-4	The common type of jet fuel in use during the Vietnam war
km	Kilometer
LOC	Line of communication

MAAGV	Military Assistance Advisory Group, Vietnam—the predecessor of MACV
MACRD	Military Assistance Command, Revolutionary Development
MACV	Military Assistance Command, Vietnam—the command in charge of U.S. military operations in South Vietnam, established February 8, 1962 (occasionally USMACV)
Manioc	A plant whose roots yield the starchy food tapioca
MC-1	The "Hourglass" spray system which the Ranch Hand planes carried with them on their initial deployment to Southeast Asia
mm	millimeter
Montagnard	A member of the highland people inhabiting the western regions of South Vietnam
MR	Memorandum for the Record
MR I, II, III, and IV	Military regions in South Vietnam ranging from MR I in the north to MR IV in the south, also called I Corps, II Corps, etc., or I CTZ (Corps Tactical Zone), II CTZ, etc.
MRI	Midwest Research Institute
Msg	Message—a communication transmitted by teletype which usually reached the recipient within hours
Mule Train	Code name for a U.S. Air Force operation which began in 1961 and which involved sending transport aircraft to fly airlift missions in South Vietnam
Napalm	A jellied gasoline formulation used in incendiary bombs
NAS	National Academy of Sciences
NLF	National Liberation Front—the political organization of the Viet Cong
NSC	National Security Council—the White House staff concerned with foreign and military policy matters
NDSM	National Security Decision Memorandum
NSAM	National Security Action Memorandum
NSSM	National Security Study Memorandum
NVA	North Vietnamese Army
NVN	North Vietnam
O-1	A small, single-engine, tail-wheel, piston and propeller driven, observation aircraft known as the "Bird Dog" which was flown by forward air controllers.
OSAF	Office of the Secretary of the Air Force
OSD	Office of the Secretary of Defense
PCS	Permanent change of station

Picloram	4-amino-3,5,6-trichloropicolinic acid—a plant growth regulating herbicide which was a major component of herbicide white
PACAF	Pacific Air Forces—the Air Force command in the Pacific
Pathet Lao	Laotian guerrillas allied with North Vietnam
POLWAR	Political Warfare
ppm	Parts per million—one part per million equals 0.000001 or 0.0001%
PSYOPS	Psychological operations
PSYWAR	Psychological warfare
Ranch Hand	Code name for U.S. Air Force herbicide operations in Southeast Asia, 1961-1971, and also a nickname for the unit flying them
RAND Corporation	A non-governmental research organization ("RAND" is the proper name, although its origins are the phrase "R and D" for "research and development.")
RLG	Royal Laotian Government
Rprt	Report
RVNAF	Republic of Vietnam (South Vietnam) Armed Forces
SAC	Strategic Air Command
SAF	Secretary of the Air Force
SASF	Special Aerial Spray Flight
SECDEF	Secretary of Defense
2d ADVON	Second Advance Echelon—the Air Force command in South Vietnam between November 15, 1961 and October 8, 1962
2d AD	Second Air Division—the Air Force Command in South Vietnam between October 8, 1962 and April 1, 1966
SECSTATE	Secretary of State
7 AF	Seventh Air Force—the Air Force command in South Vietnam after April 1, 1966
7/13 AF	Seventh/Thirteenth Air Force—the Air Force command subordinate to both 7th and 13th AF which was responsible for air operations over North Vietnam, Laos, and Cambodia
SOW	Special Operations Wing
SVN	South Vietnam
SEA	Southeast Asia
SOS	Special Operations Squadron
Subj	Subject
T-28	A single-engine, tricycle gear, piston and propeller driven trainer used in South Vietnam, Laos, and Cambodia as a fighter plane
TAC	Tactical Air Command

TACC	Tactical Air Control Center
TAS	Tactical Airlift Squadron
TAW	Tactical Airlift Wing
TCDD	See dioxin
TDY	Temporary Duty
13 AF	Thirteenth Air Force—the Air Force command in Southeast Asia responsible for South Vietnam before 2d AD was placed direcly under PACAF in 1965.
2,4-D	2,4-dichlorophenoxyacetic acid—a synthetic plant hormone herbicide which was a major component of herbicides purple, orange, and white
2,4,5-T	2,4,5-trichlorophenoxyacetic acid—a synthetic plant hormone herbicide which was a major component of herbicides purple and orange
UC-123	The designation adopted in November 1965 for the transport aircraft used by the U.S. Air Force to spray herbicides in Southeast Asia. The UC-123B had two reciprocating engines, while the UC-123K in addition had two jet engines.
U.N.	United Nations
U.S.	United States of America
USAF	United States Air Force
USAID	United States Agency for International Development (Also AID)
USIA	United States Information Agency
USSR	Union of Soviet Socialist Republics
VC	Viet Cong—guerrillas fighting against the South Vietnamese government
Vietnamize	To train and equip the South Vietnamese to perform functions once done by Americans and other foreign forces
VN	Vietnam (North and/or South, but usually in this study, South)
VNAF	(South) Vietnamese Air Force
ZI	Zone of Interior—the Continental United States

Bibliographic Essay

This history has been written primarily from documents which are, or were at one time, in files of the Department of Defense and its subordinate agencies. Many of the documents originally carried security classifications, but the passage of time has led to the automatic declassification of many of them, and the obstacles to the declassification of most of the remainder are probably minor.

Policy matters during the pre-1965 period came from documents retired from the files of the Assistant Secretary of Defense for International Security Affairs and the Air Force plans staff. Documentary sources for operations during the same period are somewhat sketchy compared with the later years, with the best single source being Capt. George T. Adams' history of TAC's Special Aerial Spray Flight's operations in Southeast Asia between 1961 and 1964. Dr. James W. Brown's two reports on his vegetational spray tests in South Vietnam before Ranch Hand arrived provide the best information about that period. To supplement the documents, the author conducted interviews with three veterans of the Ranch Hand operation in the early period, and they provided much valuable information which was not available elsewhere.

From about 1966 on, the Ranch Hand unit histories are the prime sources for details on operations. Two Project CHECO reports and one Corona Harvest study supplement them, and although in many cases these are secondary sources, in some cases they contain information not found elsewhere. Documents and messages were also extracted from MACV, CINCPAC, JCS, and Seventh Air Force files and from microfilm maintained at the Office of Air Force History and the Simpson Center, Maxwell AFB, Alabama.

Material originating at the State Department or the White House usually came from Defense Department files which had received a formal "information" copy. Information concerning the ecological and health controversies surrounding the Ranch Hand operation mostly came from open sources such as the Library of Congress' technology assessment published in 1969, the Geneva Protocol hearings conducted in 1971, and the 1974 report of the National Academy of Sciences.

Many of the important sources supporting this study would not have been available to the author without the diligent and painstaking research conducted over several years by Doris Krudener, formerly of the Office of Air Force History. She collected many documents from active files maintained at that time in various places in the Pentagon, and it is likely that the offices concerned later discarded many important papers prior to retiring their records to the National Archives. The results of her work point out the value of having an historian on the scene when events are occurring to preserve important information for future researchers.

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