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HERBICIDES AND MILITARY OPERATIONS

VOLUME I

MAIN PAPER

Prepared by

Engineer Strategic Studies Group
Office, Chief of Engineers
Department of the Army

February 1972

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CONTENTS

ABSTRACT

The purpose of this study is to determine the military effects of herbicides when used in support of military operations. This study, based upon currently available herbicides and means of dissemination, included research and analysis of historical, experimental, and theoretical evidence. In addition to applying earlier studies and war gaming and other military simulations, this study considered the results of a specially conducted survey of US military officers with first hand knowledge of the use of herbicides. A new analysis of quantitative evidence on this subject confirms some military benefits identified in earlier studies. This study concludes that herbicides can be useful as a specialized support to military operations as long as several specific circumstances exist.

SUMMARY

This is a three-volume study on the utility of herbicides to military operations. Volumes I and II are UNCLASSIFIED, and Volume III is classified SECRET. All classified data were placed in one volume to make maximum information from the other volumes more readily available. Volume I contains the main report, and Volumes II and III contain backup data and detailed discussions that contribute to the analysis.

All available documentary evidence was considered, and a new survey of US military officers was conducted. Although no new laboratory or field experiments were performed, study team members did observe and photograph areas of prior herbicide use.

Herbicides have been used in the Republic of Vietnam for almost 10 years as one of the many military programs for neutralizing enemy forces or their capabilities. The experience there proved a complex but valuable source of information for study and analysis. Earlier studies identified several military benefits of herbicides. In this study, a survey of US military officers, a new quantitative analysis of military actions before and after spraying, and a theoretical approach to future conflicts have confirmed the contributions of herbicides in the following activities:

a. Dislocating enemy combat strength from its base areas and routes of infiltration.

b. Securing rights-of-way for friendly forces.

c. Insuring the security of fixed friendly installations.

d. Disrupting enemy food supply by the destruction of their crops.

The research for this study included the analysis of replies to specially prepared questionnaires. The survey posed straightforward questions about personal knowledge of the application and effects of herbicides and alternatives. All services agreed that defoliation assisted their mission performance. There was general agreement that missions would have been possible but more difficult without defoliation. Defoliation assisted direct observation greatly, both on the ground and from the air. Defoliation of the areas surrounding fixed bases greatly assisted in their defense. Crop denial caused the enemy to change his operations.

This study included a review of past evaluations of herbicides in support of military operations. Findings and conclusions from several major evaluations were compared with the survey results which were collected in this study. Both past studies and survey results confirm the improved visibility resulting from herbicides, the ability to disrupt enemy operations in remote areas, and the technical adequacy of the herbicide distribution techniques.

This study tested the association between herbicide application and other military activity in the Republic of Vietnam based on data extracted from files maintained at the National Military Command System Support Center. The study team categorized these data for actions inside and outside sprayed areas and for times before and after spraying. The conclusion is that significant net changes occurred after spraying. But the evidence is not sufficient to attribute the net changes to direct or indirect effects of herbicides delivered from fixed wing aircraft. In general, other military programs were also underway and may deserve partial credit for net improvements over time.

This study modified selected methods of force estimation by including the effects of herbicides. The analysis indicated that, under the respective theories of combat, herbicides are a significant aid to military operations in counterinsurgency and of less value in terms of force requirements in conventional (linear) warfare.

The study observes that herbicides produce only two assured military effects and then only in the sense that the creation of military opportunities is a military effect.

a. Both horizontal and vertical visibility can be improved where foliage obstructs lines of sight.

b. Crops usable by an enemy can be destroyed in a matter of hours or days at suitable times in the growing cycles.

The study concludes that where an enemy relies on foliage to achieve concealment, stealth, and deception, herbicides can be a contributing factor in disrupting or dislocating enemy operations. The net effect depends on time, alternatives open to the enemy, the enemy's determination, and the extent to which friendly forces exploit the opportunities created by herbicides. Herbicides can be useful as a support to military operations provided that special circumstances exist.

HERBICIDES AND MILITARY OPERATIONS

I. INTRODUCTION

1. Purpose. The purpose of this study is to determine the military effects of chemical herbicides used in support of military operations.

2. Scope. The study investigates the utility of herbicides to military operations. It specifically considers currently available herbicides, their means of dissemination, and some alternatives. Consideration is given to past, current, and future military operations. The study does not include direct consideration of the ecological and physiological effects of defoliation. The Secretary of Defense, as required by Public Law 91-441, 7 October 1970, has contracted with the National Academy of Sciences for a separate comprehensive study and investigation to determine those effects of the defoliation program in the Republic of Vietnam (RVN).

3. Methodology. Throughout, the research has been passive in the sense that no new laboratory or field experiments were performed to provide data for the study. Analysts sought and evaluated historical, prior experimental, or theoretical evidence suspected of being relevant to the subject. US military officers with experience in Southeast Asia were surveyed. New desk and computer analyses were made on existing data, earlier studies, and war gaming and other military simulations and results.

4. Assumptions. Because Southeast Asia remains the unique source of historical information about the military uses of herbicides, the record there is considered in depth. Other areas where the United States has treaty obligations are recognized as sites of possible military conflicts of minor to major proportions. As real as the Southeast Asian experience is, it need not be representative of these other areas, their vegetation, or any future conflicts. Nevertheless, it is assumed that the herbicides used and their effects on vegetation are representative. It is also assumed that the range of administrative and physical procedures imposed for herbicides used in RVN is representative of possible future uses. Annex F investigates possible future uses whose administrative and physical procedures are assumed to permit the adequate and timely use of herbicides. Although there are errors in the historical record, it is assumed that any under or over reporting is neutralized in the course of this study's analysis of herbicides in RVN.

5. Herbicide Systems.

a. Herbicides. Several herbicides were used to reduce foliage in RVN. The most important of these are Agents Orange, White, and Blue.

(1) Agent Orange was used to defoliate forests and jungle areas. A growth regulator, Orange is most effective when used on broadleaf plants during the fast growing, rainy season. Foliage becomes dry and brown within 1 to 2 weeks and later drops. Orange also is capable of killing food crops.

(2) Agent White, also a growth regulator, is slower acting than either Orange or Blue. White is most effective on broad-leaf plants. Because its effects are most easily localized, White was used to reduce chances of damage to nearby, sensitive plants.

(3) Agent Blue is a fast acting desiccant that causes dehydration and browning of foliage and is the agent of choice for narrow-leaf plants. Its effects appear in 1 to 2 days. Blue is less persistent than the other two agents. Its characteristics made it most useful for crop destruction.

b. Dissemination of herbicides. Spraying from fixed wing aircraft accounted for the most extensive use of herbicides in RVN. Spraying by hand and from rotary wing aircraft also occurred but on a much smaller scale.

6. Limiting Influences. Several limitations on herbicides that can be identified without new analysis are listed here.

a. Notions of effect. Herbicides, in a strict sense, have direct effects only on vegetation. All military effects, apart from the destruction of food crops, must be indirect. Herbicides affect vegetation in a way that improves visibility and can create military opportunities; but unless these opportunities are exploited, there generally cannot be a military effect. Bare tree trunks or limbs and fallen foliage are not necessarily insignificant obstacles to sight. In general. any asserted net military effect dependent on improved

visibility from point A to point B must include allowance for improved visibility from B to A.

b. Air superiority. Spraying from aircraft requires air superiority or aircraft invulnerability.

c. Weather. Weather conditions influence not only the accuracy of spraying from aircraft but also whether spray missions can be flown at all. The times of effect of the herbicides also are affected by weather.

d. Times of effect. Herbicides do not produce instantaneous defoliation or crop destruction. Times of effect range from hours to months. Where vegetation forms multiple canopies, repeated spraying may be necessary. Time must elapse before lower canopies are exposed and can be sprayed. An enemy can but does not have to react at any time.

II. HERBICIDES IN THE REPUBLIC OF VIETNAM

7. Background. By comparison with many other actions in support of military operations, the use of herbicides has had a short history and only a small area of application. The records of military actions and uses of herbicides in RVN describe a variety of complicated events. Authority to use herbicides in RVN was requested in 1961, and limited testing followed shortly. The program was expanded to its maximum in 1967 and 1968. The program continued at a reduced rate until April 1970, when the use of Agent Orange (the most commonly used chemical) was terminated. Most subsequent spraying was for crop destruction, and all aerial herbicide spraying was stopped in May 1971. Later in 1971 there was only limited use of herbicides to reduce vegetation around the perimeters of fixed installations.

a. Small-scale uses of herbicides, for example around friendly base perimeters, were at the discretion of area commanders. Such uses seemed so obvious and so uncontroversial at the time that little thought was given to any detailed or permanent record of the uses or the results.

b. The largest scale use, the spraying of herbicides from fixed wing aircraft, was subject to a careful target approval procedure. That procedure required consideration and approval by the Government of Vietnam (local and national), the US Ambassador, and the Commander, US Military Assistance Command, Vietnam (COMUSMACV) before each area was

treated. This time-consuming process was never simply a formality. Although the approval system did leave a detailed record up to and including the completion of each aircraft spray sortie, events in the sprayed areas were not as well documented.

c. An ultimate objective of the herbicide program, just as of almost any other military program, was to neutralize enemy forces or some of their capabilities. Herbicides could contribute to the achievement of that goal only through a chain of events and effects. Two first links in that chain were to improve visibility where the enemy was or might be and to destroy food crops otherwise destined for enemy consumption. The places where visibility was to be improved fall into four broad categories: enemy base areas, enemy infiltration and supply routes, friendly base areas, and friendly lines of communication (LOC). In terms of real geography, some of these areas overlap. The addition of places where enemy crops were grown makes a list of five types of potential herbicide targets.

d. The following evaluation of the military utility of the herbicide program in RVN draws heavily on the three largely independent sources listed below and treated separately in Annexes C, D, and E.

(1) The responses of several hundred US military officers to a specially prepared questionnaire.

(2) The many reviews and analyses of the herbicide program made while the program was in progress.

(3) Records of military actions and fixed wing spray missions provided by the National Military Command System Support Center.

8. Survey of US Military Officers. The research for this study included the analysis of replies to specially prepared questionnaires. The survey posed straightforward questions about personal knowledge of the application and effects of herbicides and alternatives. The subjects ranged from general impressions to specific mission examples. Several hundred US military officers who served one or more tours in Southeast Asia responded. Few replies were unfavorable to herbicides, and then only with regard to a few specifics. Officers' responses assert:

a. For vegetation effects.

(1) The period from application to maximum defoliation was from 3 to 8 weeks, depending on agent, season, and weather. Herbicides applied to food crops were effective in 1 or 2 days.

(2) The improvement in visibility provided by defoliation generally lasted 4 to 6 months.

(3) The effects of defoliants were in accord with planning factors.

(4) Effects of defoliation missions generally met the expectations of tactical commanders.

(5) For clearing foliage, herbicides are more effective than napalm or HE bombs, about equal to slash and burn, and less effective than Rome Plows.

b. For military effects.

(1) All services agreed that defoliation assisted their mission performance. There was general agreement that missions would have been possible but more difficult without defoliation. Defoliation impeded only those few missions which required concealment for friendly forces operating in enemy areas.

(2) Defoliation assisted direct observation greatly, both on the ground and from the air. Estimates of improvement in vertical visibility varied widely, but averaged 40-60 percent. Observation by night vision devices and by radar was improved to a lesser degree.

(3) Defoliation of the areas surrounding fixed bases greatly assisted in their defense.

(4) Friendly casualties from ambush were reduced significantly by defoliating along friendly LOC. Friendly casualties from other causes and in other areas of application were reduced slightly.

(5) Enemy casualties from unit and support weapons were increased slightly by defoliation. The enemy avoided heavier casualties by avoiding defoliated areas.

(6) Defoliation decreased significantly the number of small arms and heavy weapons attacks on friendly vessels, and it decreased slightly the accuracy of weapons used in those attacks. The number of attacks by naval mines was not affected. The effectiveness of defensive or retaliatory fire was increased significantly.

(7) Crop denial helped to achieve RVN political and military objectives. It made the enemy change his pattern of operations and about half the time made him change his area of operations. Where herbicides were used for crop denial, the distinction between crops grown for use by the enemy and crops grown by noncombatants not supporting the enemy was usually reliable.

c. Detailed tabulations of the replies to questions are recorded in Annex C and its appendixes. Apart from crop destruction, vision is the key link between herbicides and their military effects. Much of the personal experience favorable to herbicides probably derives from an accumulation of confidence in being able to see better whether or not there is anything more to see. Although the study relied on no theoretical model to compare responses to general and specific questions, the officers' favorable general impressions seem out of proportion to favorable specifics.

9. Evaluation from Other Studies. This study included a review of past evaluations of herbicides in support of military operations. Findings and conclusions from several major evaluations were compared with the survey results which were collected in this study to provide a basis for the conclusions discussed here and reported in detail in Annex D.

a. Review of past studies and results of the survey indicate that the management and administrative constraints and the attitudes

of noncombatants were unfavorable to the objectives of the herbicide program.

(1) Delays in obtaining target approval and priority to spray reduced the influence of herbicides on military operations.

(2) The unfavorable reaction of noncombatants worked against the Government of Vietnam's effort to extend its influence and support among the rural populace.

b. Although not favorably reported in two of the earlier studies, crop destruction using herbicides was supported by military commanders. The study team finding is that herbicides are effective for crop destruction but their use must be balanced against the location and attitudes of noncombatants.

c. Both past studies and survey results confirm the improved visibility resulting from herbicides, the ability to disrupt enemy operations in remote areas, and the technical adequacy of the herbicide distribution techniques.

d. The past studies indicate that the enemy took advantage of the Allied herbicide program by spreading propaganda about the dangers of herbicides. Although such propaganda appears to have been directed mainly at the civilian population, some combatants believed the information. In some instances, enemy forces fled areas in fear at the time of spraying, long before any effects appeared on vegetation. It

is debatable whether herbicides or the enemy propaganda deserves credit for this military effect. It is clear, however, that a key reaction was psychological.

10. A Quantitative Analysis.

a. Much of this study's effort to determine any association between herbicide application and other military activity in RVN was based on data extracted from files maintained at the National Military Command System Support Center. These numerical and other historical data are relative only to spraying from fixed wing aircraft. The study team categorized these data for actions inside and outside sprayed areas and for times before and after spraying. The data characterize 175,444 military encounters in which 435,149 personnel were killed in action. The data were organized as "2x2" tables of the form

	Before	After
In	a	b
Out	c	d

where a, b, c, and d represent the subtotals for a single type of data. The element "b" represents actions inside sprayed areas after spraying. Subject to different assumptions, the questions of interest were of the form, "Is the activity inside sprayed areas after spraying different in some meaningful sense?" Several measures of difference are discussed

in Annex E. Here attention is limited to the percentage differences between observed and "expected" values, when expected values are defined in straightforward ways.

b. Although data were separable according to three classes of herbicide targets (known enemy, friendly security/counterambush, and mixed areas), these classes do not match one to one the five types in paragraph 7c. Here known enemy areas include enemy base areas, enemy infiltration and supply routes, and some crop destruction targets. Friendly security/counterambush areas are almost all friendly LOC. Mixed areas include combinations of all types. Because the areas around friendly bases were usually cleared by other means, such areas are not identified explicitly among any of the three targets of spraying by fixed wing aircraft.

c. First, results are for all herbicide targets. It is assumed, here, that unsprayed areas outside were unaffected by spraying or other actions inside the sprayed areas. Figure 1 shows changes in military action, before and after spraying, over all types of herbicide targets in the RVN. These measures do not establish cause and effect relative to herbicides. Subject to the assumptions made in the estimation procedure, the changes are significantly different from zero. Over all targets, friendly-initiated actions show large decreases in both friendly and enemy fatalities. However, the larger reductions occurred

for enemy fatalities. Both of these changes are partly favorable and partly unfavorable to herbicides. For enemy-initiated actions, friendly fatalities declined and enemy fatalities increased--both changes are favorable to herbicides.

CHANGES IN MILITARY ACTION

Type Change	Percent Change[a]/
Friendly-Initiated Actions	-2.7
Friendly Killed in Action	-20.9
Enemy Killed in Action	-33.3
Enemy-Initiated Actions	-2.9
Friendly Killed in Action	-3.5
Enemy Killed in Action	+9.3

a/ In sprayed areas.

Figure 1

d. Second, when the same source data were categorized under the same assumptions but according to three kinds of herbicide targets, the results were more varied. Numerical results are given in Annex E. For known enemy areas, both friendly- and enemy-initiated actions and their results were favorable to herbicides. In friendly security/counterambush areas, friendly-initiated actions were less favorable and enemy-initiated actions more favorable to herbicide use; although, both actions and fatalities increased. In mixed target areas, actions

and fatalities decreased; however, enemy fatalities decreased by more than did the friendly personnel killed in action.

e. Third, the above observations about herbicide targets are based on the assumption that changes in unsprayed areas define normal levels against which to compare actions inside sprayed areas. That is, any changes outside sprayed areas are not attributed to herbicides. However, one of the announced goals of herbicide use was to induce enemy forces to at least partially evacuate sprayed areas. Such a goal, if achieved, should have influenced military actions outside sprayed areas. The source data were again analyzed under the assumption of possible outside effects of herbicides. For friendly-initiated actions, the net changes over both inside and outside areas are decreased friendly fatalities and increased enemy fatalities. For enemy-initiated actions, the changes are reversed. In both cases, some of the changes in outside areas were large enough to offset unfavorable changes inside sprayed areas. Note, however, that this last categorization simply compares military actions before and after spraying.

f. The conclusion is that significant net changes occurred after spraying. But the evidence is not sufficient to attribute the net changes to direct or indirect effects of herbicides delivered from fixed wing aircraft. In general, other military programs were also underway and may deserve all or part credit for net improvements over

time. The areas here defined as outside sprayed herbicide targets probably were not free of herbicides. The analysis here is limited to herbicide spraying from fixed wing aircraft. Many spray sorties were not included in this analysis. An unknown portion of these may have been targeted in what have been regarded in this analysis as "unsprayed" areas. Some herbicides were applied by means other than fixed wing aircraft; some of those applications may have fallen in the "unsprayed" areas. Some of the other means of defoliation may have reduced vegetation in the "unsprayed" areas. Most significantly, perhaps, the other sources of information are in agreement with the assertion that herbicides contributed to area denial programs and the transfer of some action outside sprayed areas. The other sources also confirm an increase in the flow of civilian and friendly military traffic. The friendly security/counterambush areas identified in this analysis lie mostly along roads and waterways where incidents and fatalities per unit of LOC throughput may have declined.

11. Summary of Herbicides in RVN. Herbicides were useful in supporting military operations in RVN in selected instances. The measures developed in this study are derived from survey responses from military personnel who conducted operations in RVN, data on frequency of incidents and fatalities both inside and outside sprayed areas and before and after herbicides, and a review of earlier evaluations of herbicide results considered in view of the survey responses.

a. Herbicides contributed to area denial programs when observation and surveillance were maintained in the treated areas. In RVN herbicides contributed to friendly operations directed against enemy infiltration and enemy base areas. The enemy was able to relocate and resume his activity only after some disruption and at a net loss. In selected areas (Rung Sat Special Zone, Cau Mau Peninsula, and coastal regions of the Delta), herbicides reduced the mangrove forest--thereby denying concealment to the enemy (photographs in Appendix B-4). The enemy was unable to maintain an effective force in these areas.

b. Herbicides contributed to friendly operations to counter ambush threats near roads and waterways and to secure fixed installations. Many survey responses report that the use of herbicides around the perimeter of bases and installations is the most effective use of herbicides in RVN.

c. Herbicides destroyed enemy crops, but the enemy was able to compensate and overcome localized food supply shortages. At most, the crop destruction program harassed the enemy.

d. Although the results of comparing incidents and herbicide sprayings are varied, there is evidence of some economy of friendly force in treated areas. In sprayed areas, the rate of friendly-initiated incidents increased while both enemy and friendly fatalities were sharply reduced--enemy fatalities more so than friendly fatalities.

The evidence indicates an enemy tendency to reduce forces in the sprayed areas.

e. The herbicide program in RVN has been inexpensive when judged against military systems in general. Low cost alone is not a justification for herbicides or any other program. However, if foliage is to be reduced or destroyed, particularly in remote areas, herbicides have no known strong economic competition. (See Appendix B-2.)

III. HERBICIDES IN FUTURE CONFLICTS

12. General. The prediction of force requirements remains one of the most interesting and controversial subjects for military analysis. The techniques used range from rules of thumb to very large manual and computer simulations. Despite probable denials, all the methods are much more theoretical than empirical. Most of the approaches share an important property: Friendly force requirements depend on friendly objectives, enemy strengths, and enemy objectives. Such dependence is implied by the word "scenario." That many different scenarios may state equally probable futures is at once true and troublesome. Many war gaming and other models of combat are purported to represent, among other things, vegetation. And (to the extent that a single lumped parameter can describe rocks, trees, fences, bushes, and terrain in general) many of models do represent vegetation or foliage. This study sought those methods of force estimation that seemed most amenable to adjustments for reductions in foliage. Three approaches were applied: a simulation of unit engagements, a theory of search operations, and a representation of theater-level combat.

a. DYNTACS. DYNTACS is a developmental, high-resolution computer simulation of engagements between mechanized units. It includes treatment of line of sight based on a digitized description of terrain and a stochastic representation of vegetation. The simulation

logic permits elements of both forces to adapt their movements and other actions to terrain and visibility. Over two dozen DYNTACS runs were made expressly for use in this study. A base case and two patterns of reduced vegetation were simulated for an attack against a defended position. A preliminary analysis by the Engineer Strategic Studies Group (ESSG) study team was inconclusive.[1/]

b. SPECTRUM. The Portfolio of General Purpose Force Requirements (SPECTRUM) is a series of 106 scenarios for several theaters of operations and includes estimates of the force requirements (without consideration of altered vegetation) for all scenarios. For this herbicide study, a terrain-vegetation parameter was modified for each of five basic SPECTRUM scenarios. In a desk analysis, new force requirements were estimated using the modified terrain-vegetation parameter.

13. Insurgency. The original SPECTRUM analyses of insurgency conflicts used a force density theory (force requirements based on geographic area rather than enemy strength) to estimate offensive counter-insurgent force requirements. The patrol is regarded as the primary offensive element in counterinsurgency. The intensity of patrolling activity in the insurgent area is the frequency that a given point is checked by a patrol.

1/ The Systems Analysis Group, Combat Developments Command, US Army (home of the DYNTACS model)--as part of continued DYNTACS development--plans to extend examination of the runs.

a. Method. For this study, the width of a patrol sweep was increased by factors developed from herbicide effects on the kinds and amount of vegetation in the areas of postulated insurgency conflicts. The width of the patrol coverage was extended according to the effectiveness of herbicides in Figure F-1.

b. Results. In each of the two specific insurgency scenarios investigated, offensive counterinsurgent forces required to resolve the conflicts are reduced by over 50 percent by using herbicides to reduce foliage. The impact of herbicides on the defensive counterinsurgent forces was not treated quantitatively but qualitatively; the improved visibility would tend to reduce these forces as well. Because no theory of counterinsurgency is highly developed or widely accepted, theoretical predictions have not been declared official estimates nor have they had great impact on military programing. Nevertheless, the results of this study's analysis of the record of herbicide spraying and other military actions in RVN and the results of its survey of US military officers tend to confirm the direction if not the degree of the above theoretical estimates for counterinsurgent forces.

14. Conventional (Linear) Warfare. Conventional warfare in the SPECTRUM scenarios was analyzed using a different model of combat. In it, selected characteristics of opposing forces are assigned relative values. Forces are assumed to maintain contact and may attack or defend

for extended periods. Terrain factors and force posture factors influence the outcomes of simulated conflicts.

a. Method. In this study, herbicides were assumed to produce effects on vegetation equivalent to the modification of terrain-vegetation and defensive posture factors. Herbicides used in support of an attacking force are assumed to enable the force to move through vegetated areas as though there had been a net reduction in natural barriers to movement. In support of defending forces, herbicides are assumed to strengthen the defender's position by improving fields of fire and reducing the avenues for concealed attack.

b. Herbicide results. In an offensive situation, the effect of herbicides is to reduce the number of days required to advance in a sector. In a defensive posture, the effect of herbicides is to increase the days of delay achieved in a sector. In both cases, the use of herbicides is limited to parts of the combat zone where vegetation influences the military operations. The main effects of herbicides are limited to these areas; the force requirement elsewhere in the combat zone is less affected. When herbicides are used by the attacking force, the estimated impact is a reduction of 3 to 4 percent of the offensive force requirement for the entire theater. When herbicides are used by the defending force, the force reduction is somewhat less over the entire theater.

15. Summary of Estimated Force Requirements. The effects of herbicides on vegetation were introduced in five SPECTRUM scenarios; the outcomes were evaluated. The analysis indicated that, under the respective theories of combat, herbicides are a significant aid to military operations in counterinsurgency and of less value in terms of force requirements in conventional (linear) warfare. For counterinsurgency operations, the theoretical offensive force requirements are reduced by over 50 percent; for conventional linear warfare, the requirements are reduced by about 3 percent.

16. Survey Response. Without reference to the specific nature of conflicts, the respondents in the survey discussed in paragraph 8 estimated the need for herbicides in future conflicts as shown in Figure 2.

FUTURE NEED FOR HERBICIDES

	Yes	Perhaps	No
Army Chemical Officers	28	5	0
Army and Marine Commanders and Advisors	238	83	20
Air Force and Marine Air	145	116	38
Navy	107	35	9
Total Respondents	518	239	67

Figure 2

IV. RESULTS OF STUDY

17. Observations.

a. The ultimate objective of the herbicide program has been the same as that of most other military programs, to neutralize enemy forces or some of their capabilities. In this sense, the enemy was always the only real target of herbicides; vegetation was always only an incidental. Yet, most of the available record is a description of incidentals. Unfortunately, the herbicide program has been measured most in terms of itself, vegetation, and the reactions of friendly forces rather than in direct reference to the enemy, what he wanted to do, and what he actually did. This study has been an attempt to bridge the gap. It too has had to apply indirect measures to indirect evidence; however, this method provides a sound perspective and the basis for significant observations.

b. Most military effects of herbicides can only be indirect. Vegetation may obstruct sight and movement or provide food, but foliage is never the enemy. Herbicides can retard, injure, or kill many kinds of vegetation. Such results are physical, directly observable, and easily attributable to the unique act of applying a herbicide. Apart from a potential for directly interrupting the food supply of an enemy, herbicides must produce their other military effects through some psychological reaction. Although the attitudes of civilian populations

have been discussed often in this context, the psychological reactions of combatants have not. Combatants' deeper, perhaps subconscious, reactions are the missing links in many attempts to relate herbicides to their military effects. The questionnaires were not designed as psychological tests nor were replies analyzed as such. But, a partly psychological interpretation of survey results indicates that the officers agree visibility was improved in many circumstances, regard the improved visibility as beneficial, but make no or little association between improved visibility and specific events.

c. Nature and technology provide militarily important opportunities for concealment, stealth, and deception in land, sea, and air. The measures and countermeasures for exploiting or reducing such opportunities produce both physical and psychological effects and sometimes create new opportunities. Many opportunities created by herbicides almost certainly have gone unexploited, unreported, or unnoticed. From the first, the potency of herbicides was recognized. Elaborate administrative and physical safeguards were imposed early and throughout the program of spraying by fixed wing aircraft in RVN. One consequence of this great care was a purely administrative process, often of weeks or months, between a request for herbicides use and an actual application. In the interval, the vegetation usually remained stationary; people, whether friend or enemy, were not liable to the same constraints.

Shorter additive delays occurred when the weather was unsuitable for aircraft spray missions. Total delays of weeks or months, whether necessary or not, quickly shaped commanders' and advisors' practical definitions of military opportunity. In some cases, herbicides produced directly observable effects on vegetation within a day or two of application. But the historical record of delayed herbicide use in RVN does not reveal much, if anything, about the military effects of herbicides used at or near the purely chemical limits of timeliness.

d. Although use of herbicides was novel to military operations, the military aims beyond the effects on vegetation were conventional. The existing reporting systems were also conventional. It is not surprising that events still novel to human experience generated so many different interpretations. Some of the apparent verbal and numerical disagreements are not disagreements at all; plants and people often simply reacted in different ways to events that differed in kind, time, and place. The relatively high predictability of the effects of herbicides on vegetation is no assurance that friendly or enemy forces or noncombatants will react predictably.

18. Conclusions.

a. Herbicides produce only two assured military effects and then only in the sense that the creation of military opportunities is a military effect.

(1) Both horizontal and vertical visibility can be improved where foliage obstructs lines of sight. At fixed range, the fraction of a surface concealed by foliage can be reduced. The limiting range of visibility can be increased.

(2) Crops usable by an enemy can be destroyed in a matter of hours or days at suitable times in their growing cycles. Given plant type, growth stage, weather, and chemical agents and dosages, the quantitative physical effects on vegetation are predictable. All other usually asserted military effects of herbicides require the exploitation of any opportunities implicit in the above two at much less predictable net benefits.

b. Where threats to the vulnerabilities of current delivery systems are negligible, herbicide use is economical and easily mobilized compared to military systems in general. The means of reducing risks to the delivery systems increase the costs of delivery or the risks of misapplication or both.

c. Among previously identified advantages of herbicides that can be accepted without new quantitative data and analysis are:

(1) Herbicides provide the safest means of preventing regrowth over previously cleared, since-mined areas. Such areas are typical near-permanent or semipermanent friendly bases where there is danger of enemy infiltration. Initial clearing may be achieved without the use of herbicides.

(2) Herbicides seem the only economical way to reduce covering foliage along inland waterways. There, otherwise, an enemy can too easily exploit the vulnerability of waterborne, near-shore traffic.

d. Herbicides are effective in destroying enemy crops only when enemy crops are isolated from those of noncombatants and when noncombatants whose crops may be affected are informed and understand the reasons for a crop destruction program.

e. The terrain-vegetation factors used in the theoretical methods for predicting ground force requirements are adjusted for reductions in covering foliage as follows:

(1) In counterinsurgency operations, smaller force requirements or the faster achievement of goals is predicted.

(2) In conventional (linear) military conflicts, herbicides (when applied early enough) can yield, at most, localized reductions in force requirements. The estimated reductions in force requirements along an entire front and in depth are small.

f. Where an enemy relies on foliage to achieve concealment, stealth, and deception, herbicides can be a contributing factor in disrupting or dislocating enemy operations. The net effect depends on time, alternatives open to the enemy, the enemy's determination, and the extent to which friendly forces exploit the opportunities created by herbicides. Herbicides can be useful as a support to military operations provided that special circumstances exist.

ASDIRS No:
Study Category: Development Studies
Initiated by: Environmental and Life Sciences, DDR&E
Study Sponsor: OCRD
Study Agency: Engineer Strategic Studies Group
Reference No: TOPOCOM ID No. 9022300
Title: Herbicides and Military Operations (U)

Study Subcategory: General
Starting Date: May 1971
Completion Date: January 1972
Availability Date: February 1972

Abstract: The purpose of this study is to determine the military effects of herbicides used to support military operations. This study, based upon currently available herbicides and means of dissemination, included research and analysis of historical, experimental, and theoretical evidence. This study considered the results of a specially conducted survey of US military officers with first hand knowledge of the use of herbicides. A new analysis of quantitative evidence on this subject confirms some military benefits. This study concludes that herbicides can be useful as a specialized support to military operations under several specific circumstances.

Time Frame: Current

Study Descriptors: Doctrine; land warfare; CBR; target acquisition; counterinsurgency; Southeast Asia; applications; models; effects; performance.

Classification: Volume I UNCLASSIFIED
Volume II UNCLASSIFIED
Volume III SECRET

Contributes to: Operations; planning; doctrine; conduct of military operations; force requirement planning; military effectiveness analysis.

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