An aerial sprayer in western Kansas in the 1950s. Photograph courtesy of Kansas State University Libraries Special Collections, Manhattan.

Kansas History: A Journal of the Central Plains 35 (Summer 2012): 116–33

Kill That Thistle:

Rogue Sprayers, Bootlegged Chemicals, Wicked Weeds, and the Kansas Chemical Laws, 1945–1980

by David D. Vail

Ralph McGinty of northeast Kansas awoke one morning in June of 1972 to a chemical nightmare. His small field of twenty-two acres in Leonardville, on which he grew mostly fruits and vegetables, had been illegally sprayed by a plane earlier that morning. As he surveyed the damaged crops frustration turned to anger. McGinty had heard reports of a spray pilot terrorizing farming communities nearby but hoped these so-called errors were isolated events. Nevertheless, his small rows of fruits and vegetables soon died. McGinty sent a letter to the Kansas Board of Agriculture:

> My fields have turned orange and yellow, my tomatoes are wilted, and my fruit trees are dead and dying . . . all by the same pilot who has caused destruction in several other nearby locations and is being sued by landowners that can afford to hire lawyers. In spite of such a record this man is licensed to spray. Can a lawsuit replace my crops, livelihood, or even the native trees that used to shade our house? What in God's name will shade our house . . . a lawsuit? How long must landowners sue? How long will we tolerate destruction to drift with the wind? Must I start all over again only to have the state license this same pilot or some other idiot to spray me again. Let's stop it NOW . . . this year. If these people cannot be controlled, they must be stopped.[1]

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The author thanks James Sherow, Bonnie Lynn-Sherow, Derek Hoff, and the Kansas Historical Society archives staff for their valuable research ideas and helpful comments. The author also extends his gratitude to the Society for supporting his research through a 2009 Alfred M. Landon Historical Research Grant.

1. Ralph McGinty to the Board of Agriculture's Noxious Weed Division, June 1972, Board of Agriculture Collection, box 30779, 68-07-05-19, State Archives Division, Kansas Historical Society, Topeka.

In 1976, when a plague of army cutworms attacked wheat fields throughout central Kansas, an even larger spraying accident eclipsed the McGinty Farm case. Sumner, Cowley, Harper, and Sedgwick counties all viewed aerial applicators as the primary vanguard against looming infestations of their wheat crops. An armada of sprayers arrived in February to apply endrin, a highly potent pesticide. However, chemical protection had poisonous costs, and residents experienced what some officials and witnesses would later call the "worst pesticide application disaster the nation has ever known."[2] Millions of acres were excessively sprayed by pilots who failed to follow pesticide label instructions, fly at accurate altitudes, and turn off sprayers. Debates had already been raging throughout the state regarding the dangers of agricultural chemicals and their regulation in aerial applications. This disaster, which killed a multitude of fish and livestock and poisoned fields and communities, ultimately spurred a comprehensive statewide review of many farm chemicals and their applications. Public policy changed, but in ways that expanded regulations on "safe" aerial application to prevent "outlaw" pilots from causing future disasters rather than banning chemicals that had been so effective in controlling insects and weeds in the past. As William Greenwood, an administrator in the Kansas Department of Agriculture, put it, banning these chemicals "is not the thing to do. We need to ban irresponsible applicators."[3]

Our understanding of America's chemical past has largely focused on a bright line drawn between mid-twentieth century agricultural production and environmental critiques. Historians have explored the social, political, and ecological consequences of farm chemicals as part of the larger agricultural reordering that took place after World War II. Many of these narratives address the political debates over DDT, the social activism against pesticides that Rachel Carson inspired with her 1962 book *Silent Spring*, or the growing regulatory controls of the Environmental Protection Agency (EPA) and the contentious reactions they gave rise to in the chemical and agricultural industries.[4]

Less studied and clear, however, are the ways in which chemicals and their applications were viewed, used, and controlled on the ground, or, in the case of this article, in the fields and rural airstrips of Kansas. Beginning in the immediate postwar era, the state's farm producers, specifically landowners and aerial applicators, made efforts toward crop safety and public health through a risk assessment process they believed balanced economic goals with the well-being of their fields and communities. Healthy crops for farmers and successful spraying businesses for pilots resulted in killing pests, but at the same time they required proper application practices, knowledge of the effects of chemical toxicity, and identification and reporting of dangerous pilots or shady chemical dealers. Those "thistles," who sprayed indiscriminately, failed to pay attention to labels, adulterated mixtures, or sought to poison first and survey later, were the rogues and chemical bootleggers of Kansas agriculture and they found themselves alongside other pests on the farmer and applicator's most-wanted list.[5]

Chemicals became a target of the modern-day environmental critique, and debates around their effectiveness and dangers came not only from activists or government regulators. After World War II and throughout the mid-twentieth century landowners and aerial applicators in Kansas also took the hazards of agricultural chemicals seriously and critiqued how and why they were used. While it is easy to see a link between risk and economic performance, farmers and aerial applicators also expressed concerns about the social and environmental consequences of chemical exposure and toxicity. Although farmers were increasingly pressured to use more and newer chemicals to produce greater yields and aerial applicators worked under increasingly stringent regulations and adverse public opinion to battle increasingly resistant pests, both groups, in their own way, constructed a precautionary standard that tied crop safety to public health through technological accuracy.[6]

2. "Sprayings Wreak Farm Havoc," *Kansas City Star*, March 28, 1976.

3. *Ibid*.

4. For a good overview of this history see Thomas Dunlap's *DDT, Silent Spring, and the Rise of Environmentalism: Classic Texts* (Seattle: University of Washington Press, 2008); and Christopher Bosso, *Pesticides and Politics: The Life Cycle of a Public Issue* (Pittsburgh, Penn.: University of Pittsburgh Press, 1987), xiii. Also see Joe Anderson, *Industrializing the Corn Belt: Agriculture, Technology, and Environment, 1945–1972* (DeKalb: Northern Illinois University Press, 2009).

5. A similar approach can be found in the history of antibiotics and postwar dairy production; see Kendra Smith-Howard, "Antibiotics and Agricultural Change: Purifying Milk and Protecting Health in the Postwar Era," *Agricultural History* 84 (Summer 2010): 327–51.

6. Following Naeem Eesa and L. K. Cutkomp, I define toxicity as "the capacity by which poisons and poisonous substances produce injury and their interactions with living organisms" (Eesa and Cutkomp, "Toxicity," in *Glossary of Pesticide Toxicology and Related Terms*, ed. Eesa and Cutkomp [Fresno, Calif.: Thomson Publications, 1984], 54; and "Toxicology" in *The National Institute of General Medical Sciences Online Dictionary*, publications.nigms.nih.gov/medbydesign/glossary.html). For histories of toxicity and risk see Nancy Langston, *Toxic Bodies: Hormone Disruptors and the Legacy of DES* (New Haven, Conn.: Yale University Press, 2010); Frederick Rowe Davis, "Pesticides and Toxicology: Episodes in the Evolution of Environmental Risk Assessment (1937–1997)," (PhD diss.,

In the postwar period newly designed pesticides promised a stronger defense against the many hazards involved in agriculture. But landowners, aerial applicators, and agricultural officers were also concerned with the potential perils involved in achieving such an agricultural edge. They worked together to mitigate risks, as seen in this late 1950s photograph of Dodge City spray pilot Roy Mahon in discussion with local weed supervisor Ralph Stum, who stands on the plane's wing.

In the immediate postwar period, many Kansans worried about their fields. A decade of economic and ecological volatility before World War II had taught hard lessons about the fragility and vulnerability of agricultural production. The aftermath of the war added to these fears with the powerful examples of atomic weaponry, an expanding swath of chemicals, and new applications that made many Americans, including Kansans, uneasy. Newly designed pesticides promised a stronger defense against the many risks involved in agriculture, and it is not surprising that these chemicals had short-term appeal. Landowners were excited by the possibility that they might rid fields of poisonous plants, prevent insect invasions, and protect livestock from disease. But many were also concerned with the potential perils involved in achieving such an agricultural edge. Many farmers wondered about the toxic reach of their new tools. There were long-term threats to crop and livestock health that were greater than temporary infestations. Untested or minimally tested compounds could poison farmers' crops and the soil or, just as hazardously, fail to adequately kill pests, which would hurt future yields. Domesticating grasslands to make them profitable was still the goal, but landowners also sensed growing risks to their crops from insect invasion, weedy expansion, and chemical application.[7]

As early as 1932, agriculturalists such as entomologist Roger C. Smith of Kansas State Agricultural College (now Kansas State University) began to develop an agricultural risk assessment process that would be used and adapted by landowners and aerial applicators in the decades to come. In a presidential address before the Kansas Academy of Science, Smith argued for a new way of thinking that connected the economic risks of increasing yields to the ecological health of fields and the land. Smith emphasized a new kind of "natural balance" for the Great Plains—one that acknowledged the ecological sensitivities of the grasslands as well as the agricultural production goals of farmers. To accomplish this new balance, he maintained, all Kansans

Yale University, 2001), available via ProQuest, 726028421; Jody A. Roberts and Nancy Langston, "Toxic Bodies/Toxic Environments: An Interdisciplinary Forum," *Environmental History* 13 (October 2008): 629–756; Mary Douglas and Aaron Wildavsky, *Risk and Culture: An Essay on the Selection of Technical and Environmental Dangers* (Berkeley: University of California Press, 1982); Branden B. Johnson and Vincent T. Covello, eds., *The Social and Cultural Construction of Risk: Essays on Risk Selection and Perception*, vol. 3, *Technology, Risk, and Society: An International Series in Risk Analysis*, ed. Vincent T. Covello, *et al*. (Dordrecht: D. Reidel Publishing Company, 1987); and Baruch Fischhoff *et al*., *Acceptable Risk* (Cambridge: Cambridge University Press, 1981).

7. For a historical overview of the Dust Bowl and its effects on the future of Great Plains farming see Donald Worster, *Dust Bowl: The Southern Plains in the 1930s* (New York: Oxford University Press, 1979); and R. Douglas Hurt, *The Dust Bowl: An Agricultural and Social History* (Chicago, Ill.: Nelson-Hall, 1981). For the role of atomic power in American postwar society and its relationship to toxicity see Paul S. Boyer, *By the Bomb's Early Light: American Thought and Culture at the Dawn of the Atomic Age* (New York: Pantheon, 1985); and Samuel P. Hays, *Beauty, Health, and Permanence: Environmental Politics in the United States, 1955–1985* (New York: Cambridge University Press, 1987).

By the 1950s DDT and 2,4-D had become staple pesticides for protecting the state's farms and ranches. These substances were often spread via aerial spraying, as on this Kansas field in the late 1940s by a plane labeled "aerial sprayer, 2-4-D, weed killer." But landowners remained ambivalent about such applications since they placed their fields and communities at increased risk.

needed a better understanding of their relationships to the grasslands; protecting their fields meant evaluating the vulnerabilities that came with production.[8]

Farmers were some of the "great disturbers" of the land, Smith observed, because their use of the grasslands for agricultural profits had encouraged a host of noxious invaders that endangered their crops and the region. The problem with weeds and insects was that they had the ability to adapt faster than farmers or politicians could create tools or policies to stop them. Chemicals, he warned, were promising weapons in pest control but their application also carried risks that required careful consideration and measure:

> Insect and plant disease problems are actually increasing, both in number and severity in the great plains region. Man, the disturber, will have to employ artificial control efforts for a long time, or be seriously handicapped in his labors. This biological complex reminds us of a complicated and delicate machine in which a slight misadjustment of a part affects all the others. It is as a stone dropped into a quiet pool. The ripples travel outward on all sides and upset the grains of sand all along the shore.[9]

Smith's calls for caution and an accurate assessment of "artificial controls" came amidst a growing concern over the safety of agricultural chemicals, which became particularly acute in the postwar period and beyond as Kansas's aerial application industry took off. The economic advantages of chemicals, as farmers saw it, were not reaped simply through increased agricultural profits but also had to be tied to the health of fields and communities. Aerial applicators understood that they had to go beyond just reading barrel labels and making promises about their flying expertise. Through agricultural reports, weed studies, and legislation, officials highlighted the dangers of pests and chemicals and outlined some strategies to balance the risks. Together they developed a farmland toxicity standard that measured harm by combining the agricultural risks of chemical damage to crops and possible "missprays" with the dangers posed to local communities from harmful pests and disease. Labels, warnings, and mixture ratios may have broadcasted the language of toxicity and risk according to laboratory standards—that dosage alone made the poison—but landowners, pilots, and officials expanded these principles to include the lethal consequences of weeds, land infertility, and irresponsible application.[10]

For landowners like James Brazelton it became increasingly clear that farm chemicals required cautious and measured use. Applicators, whether fellow farmers or custom sprayers, had to account for the long-term effects of toxicity, not just the immediate remedies of pest control.

8. Roger C. Smith, "Upsetting the Balance of Nature, With Special Reference to Kansas and the Great Plains," *Science* 75 (June 24, 1932): 649–50.

9. *Ibid*., 654.

10. For the historical origins of aerial crop dusting see Eldon W. Downs and George F. Lemmer, "Origins of Aerial Crop Dusting," *Agricultural History* 39 (July 1965): 123–35; David A. Isler, "Aircraft in Agriculture," in *The Yearbook of Agriculture, 1960* (Washington, D.C.: Government Printing Office, 1960), 157–63; and Pete Daniel, *Toxic Drift: Pesticides and Health in the Post-World War II South* (Baton Rouge: Louisiana University Press in association with the Smithsonian Institution, Washington, D.C., 2005).

When he had difficulty reclaiming old orchards in 1941, Brazelton blamed excessive spraying of arsenic and lead as the main culprit of what he feared was permanent infertility in a growing number of old croplands. Many growers, he wrote the *Kansas Farmer*, had tried to reclaim unusable fields with limited or no success. Their lands were unhealthy not only because of weeds or insects, but "growers here are facing a new and entirely different problem. . . . There are 'toxic plots' on orchard land where the trees once stood. It has been found virtually impossible to get a good strand of alfalfa or lespedeza on such land. Corn has been tried but does not do well." Brazelton called for closer relationships between state experiment station personnel and producers to develop methods of resuscitating poisoned lands into healthy, productive spaces. "If [agricultural experiment station officials] can say to the perplexed grower, 'Here is a crop that we know will grow profitably on your orchard land,' they will be rendering a service that will be most sincerely appreciated."[11]

Even with the risks, farmers recognized that new pesticides and agricultural aviation were powerful tools that carried great economic advantages and provided invaluable services in an emergency. Their effectiveness was demonstrable, as in this 1948 photo of two Kansas agriculture officials in a field partially treated with 2,4-D. The official on the left holds a flourishing untreated weed; the official on the right shows a truncated treated weed.

Other Kansans also wondered if the new "artificial controls" and their applications were worth the risks. *Capper's Weekly* captured their anxieties in its October 1945 report on the dangers of dichlorodiphenyltrichloroethane, or DDT. The paper claimed that the new "magical" chemicals becoming available to farmers were not necessarily what "they were cracked up to be." Insisting that its critiques were based on information gathered from Department of Agriculture research, *Capper's* warned against the "wonder drug DDT," maintaining that it was not a panacea for all pests and that users, especially farmers, should be wary of spraying it on their fields and in their homes:

> DDT is very fussy stuff. For use against each bug or insect it requires a different, sometimes complicated application. A person almost has to be an expert to use it properly. For one kind of bug you have to mix it with water. For another you have to mix it with oil. For still another purpose, it must be dusted. Government experts admit for general use around the home it is not much better than some of the popular insecticide sold before the war. One of the reasons for the Army's success with DDT is that only experts used it.[12]

Since farmers had minimal knowledge regarding the true toxicity of these new chemicals, the article explained, how could they fully understand the poisonous legacy of the substances on their lands, crops, and communities? Also, if DDT and other chemicals had to be specially blended to kill off each species of insect or weed, then how could landowners trust that sprayers had the correct mixtures and understood the correct application rates? Besides, *Capper's* insisted, DDT offered no protection against screwworms, heel flies, cattle grubs, chiggers, or the poultry mite—all insects that had long plagued Kansas ranchers. Protecting their cattle with DDT only meant at best controlling these pests, but there were no guarantees.

Farmers, the paper warned, also ran the risk of their lands becoming increasingly toxic from repeated spraying

11. James Senter Brazelton, "'Toxic Plots' Make Old Orchard Land Infertile," *Kansas Farmer*, September 20, 1941.

12. "The Magic Wonder Drug DDT Not a Panacea for All Bugs," *Capper's Weekly*, October 13, 1945.

operations. While experiments with the chemical as a "spray for fruits and vegetables [were] still in preliminary stages," tests already showed that "at a rate of twenty-five pounds per acre [it] retard[ed] the growth of most kinds of beans, onions, spinach, tomatoes, strawberry plants, and rye." In a few years of spraying "the land could accumulate injurious amounts of the chemical and make it unfit for use. Some injury to squash and cucurbits has resulted from light applications of the material." *Capper's* cautioned that DDT could also harm farmers' bodies. Growers needed to be on the lookout for shady chemical dealers who were selling adulterated mixtures and exaggerating its effectiveness and safety:

> Little is known about the toxic effect of DDT on humans. So far there has only been one reported death—in England—and there was no official investigation made of it. Persons who have worked with it and have had most opportunity to assimilate it in small amounts report mild cases of the jitters and nervousness. . . . [Furthermore] much confusion has resulted over the popular sale of DDT recently. Most users will have to learn what form or with what solution they want to buy it. There's a very specialized from of DDT for each use. Some dealers are reported[ly] selling very weak solutions and making exaggerated claims for it. To protect themselves purchasers are advised to read the labels carefully and acquaint themselves with the potency needed for the job to be done.[13]

By the 1950s DDT and even newer chemicals like 2,4-dichlorophenoxyacetic acid, or 2,4-D, had become staple pesticides for protecting Kansas farms and ranches. These substances were often spread via aerial spraying, but landowners remained ambivalent about such applications since they placed their fields and communities at increased risk. Agricultural aviation was a powerful tool, they thought, one that carried great economic advantages and provided invaluable services in an emergency, but it was also dangerous. Not only did spray pilots seem a little too brash about their work, landowners observed, but the aerial application process itself posed hazards that could make their crops and communities more vulnerable, not less.

13. *Ibid*.

The relatively new dangers posed by innovative agricultural chemicals and increasing aerial spraying were not farmers' only concerns. They had always had to contend with the threat of natural toxicity spread by weeds colonizing cropland, ranches, and pastures. The rapid growth of Kansas wheat and cattle production in the 1940s created an environment in which rogue plants proliferated, robbing, stealing, and poisoning their way across farmlands and fence lines. As Kansas State botany and plant pathology Professor Frank C. Gates observed in his 1941 weed survey for the Kansas State Board of Agriculture, the dangers of infestations largely came with the technologies of production: "Most farm animals spread weed seeds . . . [but] the more mobile power machinery of modern times, as the tractor and combine, has stepped up the tempo of weed dissemination. Cultivation and tillage tools, wagons, trucks, autos and even highway maintenance machinery act as distributors. River sand used on highways or for construction purposes may be responsible for starting new weed infestations."[14] Once in a field or grazing area, the plants took root and immediately went to work building weedy communities. This process continued in field after field and pasture after pasture stealing nutrients in the soil, taking water from more productive plants, and emitting toxins that killed livestock. Gates also warned that many weed seeds were equipped with their own tools that allowed them to move miles from the original infestation site.[15]

In addition to their mobility, rogue plants created safe harbors for other pests such as grasshoppers, army worms, and aphids, as well as a variety of crop diseases. According to Gates, farmers and agricultural officials needed to be aware of these associations in order to guard against multiple infestations:

> Many of the insect pests of crops utilize weeds for food during those times of the year when favored crops are not available. This is particularly true of numerous species of aphids and flea beetles. Wireworm, white grub and stalk borer injury is likely to occur where the weed grasses thrive. A standard recommendation for the control of those insects

14. Frank C. Gates, *Weeds In Kansas* (Topeka: Kansas State Board of Agriculture, 1941), 14–15.

15. *Ibid*., 15: "The seeds of some weeds are equipped with special devices, such as claws, beards, barbs or spines, which may become attached to animals, birds, persons or machinery, and carried considerable distances. Other seeds have special facilities for distribution by air or by water, and the tumble weeds have their own natural means of spreading seed."

> which utilize weeds is to keep the fields clean prior to planting a crop and during the growing season. It is useless to observe the safe-seeding date for the Hessian fly if the wheat land is weedy with volunteer wheat.

Gates's report demonstrates that state officials connected the mechanization of Kansas agriculture to the increase of noxious insects and weeds. It also begins to highlight the role weeds played in the development of a toxicity standard that linked pests to the synthetic dangers of chemicals and the risks of aerial application. The injurious qualities of weeds—the attributes that made rogue plants "noxious," allowing, for example, field bindweed to strangle crops, musk thistle to rapidly colonize fields, and johnsongrass, locoweed, and death camas to poison livestock or even humans unlucky enough to consume them—did more than threaten farmers' pocketbooks; they endangered overall health of cropland, animals, and agricultural communities.[16] The complex and interwoven threats posed by natural and artificial agricultural toxins forced scientists and landowners to expand the concept that "dosage made the poison." Over time they began to view the dangers of noxious pests as equal to those of poisonous chemicals and application mismanagement.

The main task for pilots in the early postwar period, then, was to develop adaptive spraying technologies and hone dispersal skills that were based as much on the interplay in environmental and chemical relationships as on their customer contracts. For aerial application to be economically effective for farmers, its aeronautical performance had to reflect crop and pest lifecycles, climatic and meteorological events, correct dosages for the acreage requiring treatment, and overall safety. To accomplish these goals, aviators first had to build the parts. Most of the booms, nozzles, and containment tanks that became standard on agricultural aircraft in the 1950s were almost nonexistent in the early postwar years. Kansas applicators essentially had to create most of their equipment by hand or hire local machinists to develop prototypes.[17]

The aircraft's containment tank presented the first challenge. In the beginning, pilots designed their own chemical reservoirs by constructing a metal tank large enough to hold the dust and liquid chemical loads and thick enough to resist the corrosive properties of most agricultural chemicals. Corrosion was especially worrisome because a leaking tank allowed toxic materials to seep into the cabin or through the fuselage into the air. Pilots not only lost expensive product, they could potentially harm soil, plants, or themselves. Many operators tried to solve this problem by installing a crude set of cloth or rubber linings inside the tank to reduce seepage. This method worked to a point, but chemicals continued to leak into the pilot's cabin or onto the ground. In later years, as agricultural aircraft standardized, tanks were double-lined to provide increased protection for applicators.[18]

Additionally, pilots installed agitators, air vents, and a series of pumps that constantly mixed the tank's contents while airborne. They devised a variety of circulation systems that typically had a filter, mixer, and air vent inside the tank as well as a miniature external propeller or hydraulic pump system that used airspeed or electricity to maintain agitation and dilution during flight. Many pilots also installed measuring windows or sight gauges that showed chemical levels. This allowed operators to quickly discover if their tanks were leaking or if a misspray occurred.[19]

The second challenge was environmental. Once pilots loaded up, taxied out, and took off, chemical mixture and containment were only two of the many factors involved in avoiding plant injury or soil contamination. The trick for pilots was to release the exact amount of chemicals necessary to treat specific pests and crops while making as few passes as possible. Spraying along rows of corn or fields of wheat required pilots to maneuver back and forth across the cropland in parallel lines, holding the distance between flight lines and swath width to effectively match spray patterns evenly over the field.

16. *Ibid*., 22. On field bindweed see H. F. Roberts, "Principal Noxious Weeds of Kansas," *Agricultural Experiment Station Circular* 84 (October 1920): 1–9; and "Noxious Weed Strangles Kansas Crops," Kansas State University News Release, March 17, 1994, 1–2. On musk thistle see Ronald McGregor, *Musk Thistle in Kansas: Observations from 1940–1985*, Contributions from the University of Kansas Herbarium 14 (Lawrence: University of Kansas, 1985); and Freeman E. Biery, "Musk Thistle Threatens," *Kansas Agriculture, Forty-Eighth Annual Report, 1964–1965* (Topeka: Kansas State Board of Agriculture, 1965), 120–23. On johnsongrass see Biery, "The Johnson Grass Problem," *Kansas Agriculture, Forty-ninth Annual Report, 1965–1966* (Topeka: Kansas Board of Agriculture, 1967), 116–18. On locoweed and death camas see Harold S. Choguill, "Some Poisonous Plants of Kansas," *Transactions of the Kansas Academy of Science* 61 (Spring 1958): 1–13.

17. Kansas spray pilots, interview by the Kansas Agricultural Aviation Association, [ca. 1990s], videotape, KAAA Conference, Hutchinson, Kansas; transcript by author in author's personal collection.

18. United States Department of Agriculture (USDA), "Aerial Application of Agricultural Chemicals," *Agricultural Handbook No. 287* (Washington D.C.: Government Printing Office, May 1965), 1–30. See also H. R. Quantick, *Aviation in Crop Protection, Pollution and Insect Control* (London: Collins Professional and Technical Books, 1985).

19. USDA, "Aerial Application of Agricultural Chemicals."

The main task for agricultural pilots in the early postwar period was to develop adaptive spraying technologies and hone dispersal skills. But first they had to build parts. Most of the booms, nozzles, and containment tanks that became standard on agricultural aircraft in the 1950s were almost nonexistent in the early postwar years. Kansas applicators essentially had to create most of their equipment by hand or hire local machinists. Some agricultural sprayers innovated quickly and built their businesses into large-scale operations. Pictured are employees of Mahon's Custom Aerial Spraying Service readying a plane in the 1950s.

Pilots had to understand the climatic and meteorological patterns of the spray location. As air and land temperatures warmed throughout the day, accuracy and chemical effectiveness diminished, creating an air-to-ground temperature differential that, if unchecked, could create dangerous and unpredictable swath patterns. In the early morning or late evening temperatures on the ground and in the air twenty or thirty feet above it were comparable enough to allow successful chemical dispersal. As morning changed to midday and temperatures increased, a convection process began to take place. This produced thermal currents that lifted chemical dusts or liquid particles into the air, carrying them well beyond the intended pattern.

Weather conditions also affected swath dispersal. Wind, more than any other factor, provided for a successful treatment or deadly mistakes. Pilots usually sprayed early in the morning when fields were still and ground-to-air temperatures were uniform, but even the slightest changes in the atmosphere or wind patterns could ground the operation. Certainly any major aerial disturbances such as thunderstorms immediately halted spraying, even against the behests of farmers who were in the midst of an insect or weed infestation. Pilots had to be able to react quickly if chemical sprays or dusts drifted beyond their targets and to continually monitor that the poisons were evenly distributed over crops rather than settling on only a few sections.[20]

Aerial applicators also needed to know the types of crops growing in their assigned fields and the chemicals needed for the job. They had to cater their sprays to the problem they were hired to combat, since weeds required different types of chemicals and dosages than insects. Landowners occasionally provided pilots with some of this information early in the hiring process but aerial sprayers needed a familiarity of the spray area to ensure that they correctly treated crops with the right dosage to prevent crop death or contamination through toxic drift. It was not enough to simply fly the aircraft; successful pilots had to be well versed in crop recognition, chemical

20. *Ibid*., 25.

toxicity, and the biological properties of weeds, insects, and soil.

A third challenge involved computation. Pilots were required to calculate the correct deposit pattern and swath spacing for each job. Since chemical mixtures and their dispersal rates affected the health and safety of the pilot, farmer, community, and environment, aerial operators often practiced their drops using water before applying actual chemicals. To achieve an accurate swath or the "dispersal sections of a surface in the plane's wake," pilots adjusted their nozzle spacing and boom width based on the label information of each chemical (or the stated mixture ratios of multiple chemicals) and the environmental conditions of the location.[21]

Pilots wanted swath patterns to stay within the designated field and effectively treat plants. Their goal of uniform coverage required spray patterns that were almost perfectly spaced. Operators had to calculate the exact distance between the first pass and the second or third coverage attempts in order to guarantee that each individual crop was evenly coated. A slight miscalculation or variation in each dispersal attempt could result in a pattern that clumped in the middle. In this scenario farmers lost on both fronts. Some sections of their fields would burn from excessive chemical exposure while other sections went without any treatment, which allowed infestations to continue unabated.[22]

Chemical application rates also mattered. The dangers of phytotoxicity, or the process by which a chemical's compounds injure plants, was a constant concern for aerial operators. Incorrect mixtures, like swath miscalculations, harmed fields: solutions that were too potent burned crops, while those that were too diluted failed to stop infestations. To achieve accuracy in the mixture ratios and rate of application for a variety of chemicals, most operators developed two application rate standards. Most jobs required approximately five to ten gallons per acre. By calculating the rate of travel, gallons per minute, and the distance between nozzles, pilots could determine a more exact application rate that would also help them accurately measure dilution rates of each chemical.[23]

A successful spray depended upon the local knowledge of farmers, the chemical expertise of agriculturalists, and the navigation of a seasoned aviator. Kansas pilots understood, however, that it was not enough to simply demonstrate their knowledge and skill in the air. Sprayers still had to earn farmers' trust, since a mistake in chemical dosage or mixture or in a spraying swath, even by the most attentive applicator, could mean the chemical death of farmers' fields. Pilots also had to be cautious about their contracts. Landowners could easily shift blame to the applicator (and they often did, whether rightly or wrongly) if a job was ineffective by claiming they witnessed cavalier flying or that a pilot mismanaged chemical mixtures.

One of the first steps toward applicator professionalism began in Hays, Kansas, where Donald E. Pratt owned and operated P-T Air Service. Pratt started building his crop spraying operation in 1946 by emphasizing both his aeronautical and chemical expertise. He learned as much as he could about the newest agricultural chemicals on the market, met with state entomologists and weed supervisors to increase his understanding of crop-pest interactions, and then purchased ten two-thousand-gallon tanker trucks, hired a ground crew, and went to work. By 1948 Pratt had spraying contracts with a majority of western Kansas wheat farmers and a reputation for accuracy. His mobile, twenty-thousand-gallon arsenal included a combination of ground and aerial sprayers that could treat over seven thousand acres in one morning.[24]

Considered by many of his contemporaries as the "Spray King of the West," Pratt established a western Kansas aerial spray tradition that combined equipment accuracy and spraying education with a successful business plan. In relatively short time, as fellow pilot Dick Reade of Missouri recalled in Marby Anderson's *Low and Slow: An Insider's History of Agricultural Aviation*, Pratt "had contracted for virtually all of the wheat land in western Kansas . . . mostly applying 2,4-D. He had everything in that country tied up and it was really quite amazing how well we managed to get the jobs done."[25]

Pratt's reputation encouraged many would-be pilots throughout the region, including Reade, to spend a sum-

21. H. R. Quantick, "Phytotoxicity," in *Aviation in Crop Protection, Pollution and Insect Control* (London: Collins Professional and Technical Books, 1985), 420.

22. See USDA, "Aerial Application of Agricultural Chemicals," 1–30. Also see the Texas A&M Experiment Station, *Handbook on Aerial Application in Agriculture* (College Station: Texas A&M Press, December 1956).

23. Stanley F. Bailey, *The Handbook of Agricultural Pest Control* (New York: Industry Publications, Inc., 1951), 112.

24. "Spray Combine: Kansas Operator Employs 40 Planes in a Big-Time Crop Dusting Business," *Aviation Week*, June 7, 1948; "Hays Air Sprayer Sees Wide Horizons for Killing Weeds by Plane," *Topeka Daily Capital*, February 20, 1949; Cheyenne County Historical Society, "Commercial Aviation in Cheyenne County," in *The History of Cheyenne County, Kansas* (Dallas, Tex.: Cheyenne County Historical Society, Curtis Media Corporation, 1987), 146–47.

25. Marby I. Anderson, *Low and Slow: An Insider's History of Agricultural Aviation* (Perry, Ga.: AgAir Update, 1986), 57.

As sprayers developed new technologies, aircraft containment tanks continued to present a challenge. In the beginning, pilots designed their own chemical reservoirs by constructing a metal tank large enough to hold the necessary chemical loads and thick enough to resist corrosion. In later years, as agricultural aircraft standardized, tanks were double-lined to provide increased protection for applicators. Pictured is an Aero Spray King outfitted with a chemical tank, produced in the late 1940s by the Ong Aircraft Corporation of Kansas City.

mer or two working for P-T Air before they returned home to start aerial spray businesses of their own. However, it was not enough for these applicators to simply show up for a job. To work for Pratt pilots had to attend his spray clinic, an intense summer "working" course. All pilots under his employment had to attend a two-week spraying school where they learned proper calculation methods for chemical dosages, various spraying techniques such as swath management, and the scientific intricacies of pest management. After they passed Pratt's exams, the newly minted aerial applicators were incorporated into his crew, which, according to *Aviation Week*, typically included "four flagmen, two planes and four pilots (or four planes and eight pilots), two tank trailers and drivers, and a station wagon with supervisor."[26] While pilots were spraying one field, clinic supervisors would direct extra flagmen from field to field, preparing for the next aerial application. Pratt essentially taught as he worked, dispatching pilots and ground crews carrying basic county maps to each new field only minutes before it was sprayed. Pilots worked in shifts of forty minutes to an hour, depending on the crop, infestation danger, and instructional activity.

But P-T Air would serve another purpose. Pratt's continued efforts to build working relationships between farmers, pilots, and Board of Agriculture personnel and his focus on accuracy as well as toxicity and risk assessment provided an important case study in the growing debates among these groups about chemical use in agriculture and the aerial application industry.[27] Farmers worried that the rapid development of new chemicals and aerial applications was occurring too quickly and with little regard for unforeseen dangers posed to their fields and communities. Pilots were concerned that the stereotype of a dirty and idiotic sprayer addicted to risk would hinder their business or encourage unnecessary regulations. Officials tried to strike a balance between agricultural production and regulation of chemicals and their application technologies.[28]

Attempting to assuage anxieties and in the hopes of developing a state plan outlining risk management and chemical use practices, Board of Agriculture officials hosted a series of conferences beginning in February 1949 at Kansas State Agricultural College. The first meeting held on the Kansas State campus focused on misunderstandings between pilots, landowners, and officials about chemical potency and equipment accuracy. Dick Mann, writing for the *Kansas Farmer*, reported that a majority of farmers and pilots arrived at the conference from Missouri, Iowa, Nebraska, and the Dakotas wanting to simply blame each other for application mistakes. Operators openly criticized farmers at some of the panels for using newer, more potent chemicals without adjusting for specific pests or even field acreage. One pilot complained to Mann that a farmer asked him to spray what he said was an eighty-acre field, but in reality was ninety-two acres. The pilot, assuming the field was only eighty acres, "made his mix for that acreage and went to work. He later found there were 92 acres in the field. This meant his application was not correct if he covered

26. "Spray Combine," *Aviation Week*, June 7, 1948.

27. "Texaco Advertisement," *Aviation Week*, April 10, 1950.

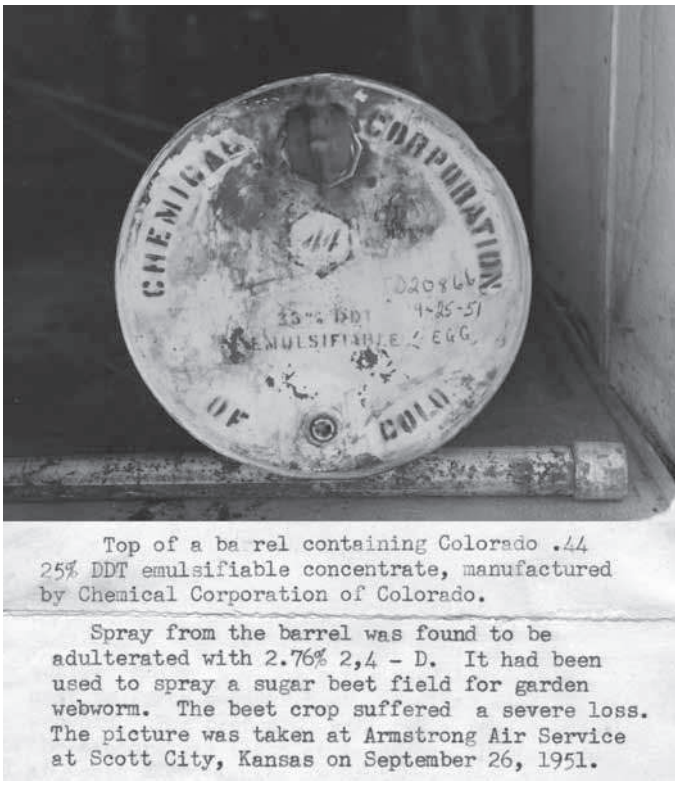
28. "Hays Air Sprayer Sees Wide Horizons for Killing Weeds by Plane," *Topeka Daily Capital*, February 20, 1949; "The Magic Wonder Drug DDT Not a Panacea for All Bugs," *Capper's Weekly*, October 13, 1945.

all 92 acres, or else he had to land and make another batch to finish the 12 acres overlooked by the farmer." Pilots also challenged farmers at the conference on their knowledge of various pest lifecycles, especially when it came to weeds. As another operator explained to Mann, farmers often misjudged the growth rates of weeds: "Time after time farmers insisted that I spray their fields even when I told them it wouldn't do any good. Then they were dissatisfied when their weeds didn't fall down."[29]

Farmers responded with their own set of critiques about aerial applicators. First landowners complained that operators had trouble keeping sprays within field boundaries. Drifting chemicals, they argued, not only destroyed crops but hurt their neighbors and innocent bystanders. Ted Yost, director of the Noxious Weed Division, confirmed this sentiment in his support for a statewide control bill that tried to address the concerns of both landowners and applicators: "a control bill is necessary to protect the farmer hiring the service, and to protect his neighbors and other innocent bystanders." According to Yost, "the farmer has paid his money and the operator is often out of the state before results on the job are apparent. . . . Last year we had definite complaints for damage to crops near fields being sprayed. We think this control bill also will protect the legitimate operators."[30]

Farmers feared the rapid growth of aerial spraying, insisting that pilots could get away with sloppy or even fraudulent work. As Mann reported, since "everybody and his Dutch uncle wants to get into the spraying business," many landowners were "deeply concerned over the possibilities of this thing [aerial application] getting out of hand." Landowners sided with state agricultural officials for increasing the size and scope of oversight. Pilots, they insisted, should take their examinations through the Board of Agriculture, allowing state officials to evaluate aeronautical ability, spray technique, and proper mixture and dispersal methods.

Pilots, however, remained skeptical of proposed regulation such as a state chemical control bill. As Mann suggested, they understood "that they have a big responsibility and say they are willing to accept it. Most of them feel there should be registration of operators. Many of them think they also should post bonds, altho [*sic*] they point out that under present laws they can be sued anyway for fraud or damage. They have their own reputations at stake and do not want to lose a paying business by doing sloppy work or laying themselves open to damage suits."



Top of a barrel containing Colorado .44 25% DDT emulsifiable concentrate, manufactured by Chemical Corporation of Colorado.

Spray from the barrel was found to be adulterated with 2.76% 2,4 - D. It had been used to spray a sugar beet field for garden webworm. The beet crop suffered a severe loss. The picture was taken at Armstrong Air Service at Scott City, Kansas on September 26, 1951.

Rogue sprayers were only part of the problem. Local formulators and dealers also took advantage of farmers by carving out a niche market built on bootlegging. Local dealers developed a process called "incorporating" by which they would mix two or three different pesticides together and then repackage the adulterated poison as a different chemical. The Kansas Board of Agriculture documented evidence of such dealings, including this September 1951 example of a barrel labeled DDT but which also contained percentages of 2,4-D. As the original caption indicates, serious damage was done to the field treated with this solution.

Roy Mahon, an aerial operator from Dodge City and president of the Kansas Flight Operators Association, went even further. The emphasis on regulation and restrictions may help protect lives and lands from missprays, Mahon argued, but many "spraying jobs are emergencies that require large numbers of units during a short time. 'There will be times when we desperately need to call in all the planes we can get to meet such an emergency. . . . Restrictive state laws might cost the farmers thousands of dollars in the emergency area by keeping out distant operators who otherwise would be available.'"[31]

By the end of the two-day affair, contention changed to consensus. Landowners and pilots agreed that their embrace of new agricultural chemicals came from a shared desire for healthy lands, which meant they would have to share the responsibility equally when managing

29. Mann, "A Bear by the Tail?," *Kansas Farmer*, March 5, 1949.
30. *Ibid*.
31. *Ibid*.

chemical risks. Aerial applicators left the conference with a new vision of their role in Kansas agriculture, namely as physicians of the fields. A move toward professionalism and standardization, they believed, would allow them to adequately protect crops from the hazards of weeds, insects, and disease. Farmers departed with assurances from Board of Agriculture officials for increased oversight over aerial spraying as well as a clearer understanding of the various factors involved in chemical application.[32]

In November 1949 Kansas spray pilots, farmers, and officials returned to the Kansas State campus to continue their debate over application practices, risks of chemical use, and the latest infestation assessments for Kansas crops. According to the *Journal of Agricultural Chemicals*, most sessions of the meeting addressed the risks of weeds and insects versus the safety of farmers and their lands. Numerous state and federal officials attended the three-day meeting and presented reports on various application methods for fertilizers and other current agricultural chemicals. University faculty, state policymakers, and the public listened as researchers addressed the poisonous compounds of 2,4-D, the numerous weed threats to Kansas wheat, the toxicology and residue problems of new insecticides in aerial application, and the correct formulas for chemical mixtures and application rates.

Donald Pratt attended and offered a report on aerial spraying innovations in western Kansas. He participated in a roundtable discussion about his experiments with aerial application of insecticides, as well as a paper presentation on the aerial spray equipment problems he had encountered in his western Kansas operations. His panel also addressed basic communication errors between ground operators and pilots and effective swath widths for the deployment of chemicals, in addition to summarizing the aerial hazards and accidents that had occurred during the 1949 season and anticipating what might occur in the upcoming year.[33]

By the 1950s and 1960s aerial application was soaring as one of Kansas's top agricultural industries. Pilots continued to use aerial and chemical-pest expertise as their main marketing ploys to get spraying contracts with ambivalent farmers and worked with weed officials to prevent county infestations. They also held annual spray meetings around the state to discuss the latest improvements in dispersal equipment and agricultural chemicals. Promotional materials in agricultural journals like the *Kansas Farmer* helped spread the word to landowners about the economic and environmental benefits of aerial spraying. Officials with the Kansas Board of Agriculture also used these journals to endorse the industry by linking their instructional programs and regulatory efforts to aerial application and weed control.[34] In the August 1958 issue of *Kansas Farmer*, for instance, the Noxious Weed Division reported on major advances in the state's aerial application industry in an effort to convince farmers that it was economical, safe, and the best way to protect or reclaim farmlands and pastures for future production. Farmers, both large and small, could also combine their fieldwork, hiring one applicator to do thousands of acres at once:

> Aerial service need not be thought of as limited only to extremely large operators. Farmers can band together to make a long "spray run swath" making for efficient operation, less turning around and conceivably a better price per acre. Some operators now will spray as little as 10 acres. By banding together, farmers take advantage of solid, uniform coverage, without skips, and with spraying by men thoroly [*sic*] familiar with proper formulations.[35]

Its endorsement of aerial application was also part of a larger expansion by the division, beginning in the late

32. *Ibid*. Mann actually began his report with this consensus sentiment: "Kansas farmers may have a bear by its tail, but fortunately they can tame it. That's the impression I got from attending the Aerial Agricultural Spraying Conference, at Manhattan, February 24. Incidentally, it was the largest aerial spraying conference ever held in the United States, with between 400 and 500 persons present for the 2-day educational meeting.

"Here is the problem, as brought out at the conference. *There are many new herbicides and insecticides on the market now that will control weeds and many of the worst insect pests that destroy crops. These chemicals compare with some of the new miracle drugs in medicine. They have the power for tremendous good, but they also have the power for great harm if improperly used*.

"Almost overnight, these powerful chemicals have come into widespread use, in spray or dust form, by both aircraft and ground equipment.

"Kansas farmers last year sprayed at least a million acres of crops—mostly wheat—for weed control, and may spray 1½ million acres this year. Demand last year was far ahead of the equipment and trained personnel needed to do the job. . . . *With this information as background you can see that many persons are deeply concerned over the possibilities of this thing getting out of hand*" (emphasis added).

33. Minutes of the Airport and Aerial Spray Conference, November 30–December 2, 1949, 1–2, Department of Entomology Records, 1904–1980, Richard L. D. and Marjorie J. Morse Department of Special Collections, Kansas State University Libraries, Manhattan.

34. "Aerial spraying Matures Despite Growing Pains," *Kansas Farmer*, January 20, 1951; and "State Weed Conference Hears Report of Expanded Programs," *Kansas Farmer*, March 1, 1958.

35. Jake Ubel, "Aerial Spraying in Kansas Doubles in Last Six Years!," *Kansas Farmer*, August 2, 1958.

Illegal mixing allowed formulators to charge farmers and aerial applicators a premium price for chemicals that were anything but safe or effective. Kansas agricultural officials did what they could to prevent such practices and their files documenting violations demonstrate they had some success. This 1950s photo, included in the Board of Agriculture's pesticide investigation files, shows what appears to be illegal mixing.

1950s and early 1960s, to address the growing risks of noxious plants by teaching the public about the ecological properties of weeds and linking them more directly to their poisonous characteristics.[36]

As the division developed new classifications for scientists and agriculturalists, it also reinforced the connections that farmers were making between the poisonous principles of weeds and those of agricultural chemicals—both were equally dangerous and both required attention, standards, and accuracy. Officials stressed in their application recommendations that chemicals were indeed toxic but so were weeds, and both could harm lands, livestock, and people if misused or left unattended. Keeping farmers' fields and families safe began with reading chemical labels, talking to extension agents and county supervisors, understanding dosage amounts and the life cycles of weeds, and hiring reliable applicators.[37]

Spray pilots also pursued a professionalism campaign of their own. In 1958 they formed the Kansas Aerial Applicators Association (KAAA, now the Kansas Agricultural Aviation Association) in an effort to challenge the perception that they were a rag-tag spraying air force. The organization also played a crucial role in helping pilots keep abreast of various technological developments in aerial spraying and to address ongoing problems and updated state regulations. The KAAA, which originally consisted of a group of twenty-two spray operators, followed many of the same principles that Don Pratt had emphasized nearly a decade earlier. The association oversaw flight training, dispersal techniques, infestation rates, and dosage requirements and encouraged professional contacts with noxious weed supervisors and county extension personnel.[38]

Another thistle, however, continued to poison the reputations of aerial applicators and contaminate Kansas farms. An aerial application "black market," run by rogue pilots and chemical bootleggers, grew up at the same time legitimate spraying operations began to thrive. It

36. Freeman Biery, "Education and Noxious Weed Control," *Kansas Agriculture, Fiftieth Report, 1966–1967* (Topeka: Kansas Board of Agriculture, 1967), 124–27; and Biery, "Informing the Public," *Kansas Agriculture, Fifty-Fourth Report, 1970–1971* (Topeka: Kansas Board of Agriculture, 1971), 162–66.

37. Robert Guntert, "Read the Label!," *Kansas Agriculture, Forty-Third Report, 1959–1960* (Topeka: Kansas Board of Agriculture, [1960]), 133–35.

38. Kansas Agricultural Aviation Association, *KAAA Membership Directory* (n.p.: n.p., 1985), 1.

was as difficult to control as bindweed and as deadly as a chemical misspray—indeed, that was often this thistle's modus operandi. These applicators charged cheaper rates than more aboveboard outfits by selling faulty mixes and spraying fields with little concern to air currents, field boundaries, or county lines. Renegade operators frequently failed to pay attention to wind direction, geography, or crop specificity. Multiple damage and injury reports made to the Board of Agriculture reveal such negligence was primarily the result of drifting chemicals. A mistake by the most attentive pilot could have irreversible effects on adjacent livestock, crop health, soil fertility, and water supplies, damaging not only single farms but entire agricultural communities. Wind speed, temperature, and other meteorological phenomena all accounted for the success or failure of chemical deployment. These uncontrollable elements challenged experienced, licensed pilots; they could result in deadly consequences when "amateurs," as Donald Pratt called them in a 1949 interview with the *Topeka Daily Capital*, refused to follow certification requirements or sprayed the wrong fields.[39]

These "itinerant, irresponsible, and illiterate pilots who got a thrill out of illegal buzz jobs" also exploited the ambivalence many farmers still felt about aerial application of agricultural chemicals.[40] These haphazard fliers knew that landowners who fell victim to chemical poisonings would most likely stay silent or file nondescript damage claims with the Board of Agriculture because they were worried about their crops' health and preventing infestations and therefore reluctant to point out the dangers of agricultural chemicals. Since many farmers, officials, and aerial applicators tended to view the dangers of chemical and natural toxicity as interwoven threats, they were reluctant to increase restrictions on pesticides or herbicides. Protecting their fields from weedy contaminants meant acknowledging the dangers of chemicals and toxic drift but not at the cost of foregoing chemical treatments altogether. Blame for chemical poisonings, they argued, fell directly at the feet of irresponsible applicators. Even when alleged intimidation by rogue pilots and excessive spray mishaps prompted more direct confrontation, as in the cases of Ralph McGinty and the 1976 endrin misapplication, landowners were not dissuaded from using pesticides. They instead embraced tighter restrictions on applicators.

However, rogue sprayers were only part of the problem. Local formulators and dealers also took advantage of farmers' chemical dependence by carving out a niche market built on as many underhanded dealings as legitimate ones. Examples of chemical bootlegging can be found early in the postwar era, when local dealers developed a process called "incorporating" by which they would mix two or three different pesticides together in an unmarked container and then repackage the adulterated poison as a different chemical. This tactic allowed formulators to charge farmers and aerial applicators a premium price for chemicals that were anything but safe or effective. Since the landowner and pilot applicator had no way of knowing what chemical was inside a container before its use, the deception was only discovered after the job, when farmers' crops either perished from excessive chemical poisoning or infestation continued because the concoction was too weak. This type of bootlegging operation often escaped detection because landowners tended to blame pilots for spraying mistakes when an application failed. Rogue dealers could also claim they simply miscalculated their mixtures because by the 1960s many pesticide manufacturers were recommending chemical combinations to deal with pest resistance and tolerance. Such recommendations were not always carefully followed, however, and mixing adulterated compounds in "unofficial toxicology labs" hidden in backrooms of hardware stores or in remote warehouses helped assure the anonymity of chemical bootleggers.[41]

Another bootlegging scheme was mislabeling. This method was more prolific since formulators often recycled empty chemical drums for the storage of new products. In an effort to "create" the kinds of poisons farmers or agricultural pilots wanted, dealers saved labels from previous containers and reattached them to new barrels filled with entirely different chemicals. This kind of marketing deception certainly played a crucial role in the incorporating process, but bootleggers just as often simply changed the labels on barrels without removing their contents. So if farmers or applicators ordered an

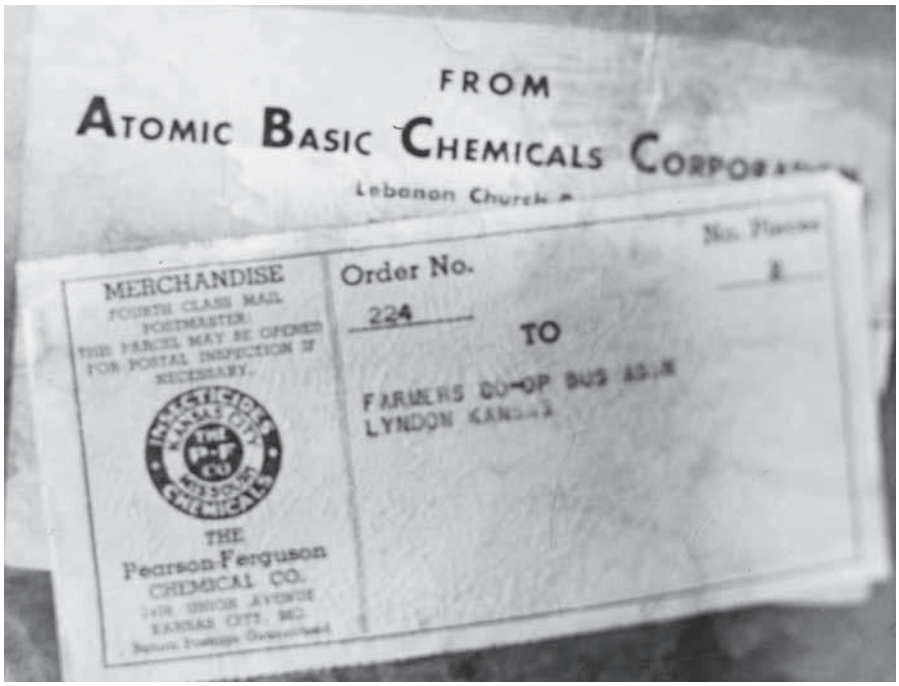
39. "Hays Air Sprayer Sees Wide Horizons for Killing Weeds by Plane," *Topeka Capital*, February 20, 1949; "Spray Damage Claims," typescript, Pesticide Registration Section Subject Files (1945–1997), 068-07-04-15–068-08-01-01, State Archives Division, Kansas Historical Society, Topeka (hereafter cited as "Pesticide Registration Section Subject Files").

40. "Spray Damage Claims," Pesticide Registration Section Subject Files.

41. "Agricultural Chemicals-Stop Sale Orders," typescript, Pesticide Registration Section Papers (1947–1984), 067-06-01-02, State Archives Division, Kansas Historical Society, Topeka; and "Inspection Report #21513—'Report on Pueblo Chemical Company bootlegging of Ambush,' 09 August 1979," 68-07-05-19, Pesticide Registration Section Subject Files.

herbicide, they might actually receive an insecticide or a combination of both.[42]

Throughout the twentieth century the state of Kansas took regulatory action to control such violations and help formalize a legal framework for farmland toxicity standards, including oversight of chemical mixture amounts, labeling requirements, and public health and environmental safety concerns. Two early efforts to control weeds and provide basic standards for the purchase and production of chemicals, the Kansas Noxious Weed Law (1937) and the Kansas Agricultural Chemical Act (1947), emphasized the risks of infestions and the dangers associated with inaccurate mixtures. While both laws provided limited oversight of weed control by describing the poisonous qualities of rogue plants and outlining procedures for the labeling and sale of agricultural chemicals, they did not go far enough to regulate users. This was especially true regarding aerial application.[43]



Another bootlegging scheme was mislabeling. This method was more prolific since formulators often recycled empty chemical drums for the storage of new products. In an effort to "create" the kinds of poisons farmers or agricultural pilots wanted, dealers saved labels from previous containers and reattached them to new barrels filled with entirely different chemicals. The example of mislabeling pictured here, in which one label is quite obviously put atop another, was recorded in Kansas Board of Agriculture files.

In a response to the concerns of farmers and pilots, the state legislature passed the Kansas Aerial Spraying Law in 1951. It established an additional set of regulations that enforced professionalism and chemical knowledge in the skies and created a framework of legal protections for landowners on the ground. Under the new law applicators had to register their plane with the state and accept a surety bond that covered a minimum of two thousand dollars for their first plane and one thousand dollars for each additional plane. Aerial applicators also had to keep detailed records of every job, including a description of the spray location, the pest to be eradicated, the chemical dosage applied, and the name of the landowner who hired them for aerial treatment. If applicators were found guilty of damages or malpractice they could face fines and jail time.[44]

Various revisions in the Kansas chemical laws throughout the 1960s and 1970s reinforced the idea that field health and contamination came from a variety of threats, including wrong chemical dosages, drift, and weedy pests, but it failed to touch on long-term pollution of soil and water or public health hazards. Landowners and pilots expressed a general willingness to abide by better legal controls on the development, sale, and application of agricultural chemicals. Most farmers and pilots agreed that reckless violators should suffer monetary and criminal consequences; some, such as McGinty, demanded it, but their concerns were as much about the extent of state and federal management as the potential harm of drift or chemical bootlegging.

In the 1970s environmentalists and the Environmental Protection Agency (EPA) issued new calls for restrictions on agricultural chemicals, challenging old ways of thinking about how such treatments were used on the farm and in the air and about the toxic threats they posed. In the preceding decades farmers, pilots, and weed supervisors had developed a standard based on education and regulation that balanced pubic and environmental health concerns with the protection of crops and profits.

42. "Inspection Report #21513—'Report on Pueblo Chemical Company bootlegging of Ambush,' 09 August 1979," 68-07-05-19, Pesticide Registration Section Subject Files.

43. Jake R. Ubel, "Regulatory Work in Kansas," *Weeds* 6 (October 1958): 468–71; and "Kansas Chemical Spray Law, 1965," typescript, 1–8, 68-07-05-19, Pesticide Registration Section Subject Files.

44. "Kansas Chemical Spray Law, 1965," typescript, 1–8, 68-07-05-19, Pesticide Registration Section Subject Files.

A caricature of rogue sprayers and chemical bootleggers attempts to warn farmers and the community about the dangers of adulterated mixtures and underhanded dealings. Cartoon courtesy of Kansas State University Libraries Special Collections, Manhattan.

Their concerns, however, were increasingly at odds with the new ecological visions of safety and health that environmentalism asserted and the EPA enforced.[45]

After the publication of Rachel Carson's *Silent Spring* in 1962, agricultural chemicals, especially DDT, became political lightning rods that incited new discussions of social activism, consumer and environmental protection, and agricultural production. Carson's central critique—that pesticides were not only dangerous to humans and wildlife but that they jeopardized ecosystems with a toxic legacy that caused permanent harm—stressed that control, precision, and protection were not possible regardless of the accuracy of applications or the responsibility of users. A new precautionary principle emerged from Carson's writings, which inspired an environmental activism that saw the health and safety of humans, wildlife, and the environment as inexorably linked—poisoning one would invariably poison the others. The real threats were not the carelessness of individual pilots or the greed of chemical bootleggers; neither were they the hazards of natural poisoning by weeds. Agricultural chemicals themselves and the companies that made them, rather, were the real dangers to the environment. In response, industry advocates and organizations like the National Agricultural Chemical Association argued passionately against environmentalist critiques by claiming that labels and dosage studies solved the problems of "potential harm" and that by lobbying to restrict the production of DDT or other pesticides environmentalists were threatening global food production and peace.[46]

The changes in the Kansas chemical laws throughout the 1960s and 1970s highlight the merging of the concerns of environmentalism and the EPA with the farmland toxicity standard developed in the early postwar period. This blending together of a complicated set of concerns was the result of cooperation between growers, aviators, and government regulators. The Aerial Spray Law, for instance, was amended in 1965 to the "Kansas Chemical Spray Law" so that any "owner or operator of dispersing equipment," including farmers, had to apply for a spraying permit and register with the state. It also stipulated that applicators of all types participate in chemical-mixture training sessions, take flying exams, keep their permits up to date, and agree to impromptu inspections, allowing officials to oversee company activities at any time.[47]

For their part, agricultural pilots remained dedicated to the principles of the farmland toxicity standard but adapted parts of it to the new social and policy realities of the era. Applicators continued to learn the new restrictions implemented by the EPA and remained dedicated to accuracy in dosages and dispersals. They were also constantly researching new techniques and technologies to address the hazards of drift and chemical contamination. As KAAA President Fred Clark explained in a 1968 interview with the *Kansas Farmer*, new methods such as ultra-low volume application (ULV) allowed pilots the ability to apply "concentrated but low-toxicity chemicals at volumes of only a few ounces per acre. This eliminates the need of diluting the chemical with water or other additives."[48] New nozzle and boom technologies in the late 1970s and Global Positioning System (GPS)

45. Langston, *Toxic Bodies*; Davis, "Pesticides and Toxicology"; and Roberts and Langston, "Toxic Bodies/Toxic Environments," 629–756.

46. National Agricultural Chemical Association, *Open Door to Plenty: The Story of How Agricultural Chemicals Are Used to Protect Our Food, Our Property and Our Health* (Washington, D.C.: NACA, 1960), 1–64. See also Dunlap, *DDT, Silent Spring, and the Rise of Environmentalism*; and Daniel, *Toxic Drift*.

47. "Kansas Chemical Spray Law, 1965," Pesticide Registration Section Subject Files.

48. Bob Bunker, "Let's Clear the Air About Aerial Application," *Kansas Farmer*, March 16, 1968.

receivers in the early 1980s increased swath accuracies, decreased toxic drift, and removed human flaggers as an applicator's primary guidance system.

In addition to these advancements KAAA endorsed a new aerial spraying instructional program at Kansas State University called Operation SAFE (Self-Regulating Application and Flight Efficiency), which explored new anti-drift technologies to reduce pilot error and environmental contamination. The program surveyed the newest "system operating procedures, computer software development, and other technological improvements" in order to preserve the health of crops, the public, and the environment. Organizers also hoped that these studies and multiple fly-in demonstrations designed to test them might "show the professional attitude of pilots and the agricultural aviation industry," which would offset claims that pilots were wild "barnstorming crop dusters."[49]

A spray pilot participates in a 2009 fly-in as part of Kansas State University's Operation SAFE in Salina, Kansas. The biannual event includes testing swath coverage by spraying colored dye on paper swatches located on the ground. Photograph courtesy of the author.

Examination of the increased use of pesticides and herbicides and their aerial application in Kansas provides a clearer picture of an important period in production agriculture. As many historians have noted, the postwar acceptance of pesticides and herbicides as an agricultural panacea "powerfully sculpted the agricultural community's attitudes toward both pest control and government regulation" and certainly shaped how Kansans farmed and sprayed throughout the mid-twentieth century. Within this context landowners and spray pilots pursued their own standard of toxicity and environmental risk that stressed accuracy, regulation, and a reasonable assurance of safety.[50] At the national level chemical companies and organizations such as the National Agricultural Chemical Association used arguments similar to those raised in Kansas against environmentalists and government oversight. At the state level, however, farmers, applicators, and officials worked together to develop a model that on the one hand challenged irresponsible applicators and demanded increased oversight for dealers while on the other hand accepted potent chemicals as the best way to protect crops.

Each of these stakeholders—farmers, aerial applicators, and government regulators—understood that chemicals, like pests, had the potential to harm. To them toxicity included a combination of poisons: some synthetic, some natural, and some human. An indiscriminate applicator was as dangerous as the materials he sprayed because of the environmental and economic damage both could cause. Pests posed their own dangers that destroyed crops and livestock. This complex web of risks underscored for farmers and state agriculturalists that calculating chemical threats and damages could not depend solely on analysis of dosages or labels. Contamination could also be caused by violators, weeds, insects, and disease. Thus, as pilots sprayed the wrong fields, dealers sold bootlegged chemicals, and weeds continued to threaten crops, landowners and custom applicators would help decide what chemical risks were acceptable in production agriculture and what practices and substances needed to be regulated or rejected. KH

49. Richard W. Whitney, "The Development of WRK Analysis Equipment and Operation S.A.F.E.," *Operation S.A.F.E. Analyst Training Class Manual* (n.p.: n.p., 2005), 1–5.

50. Bosso, *Pesticides and Politics*, 32.