

fertilization or tilling—appears to have had an effect in 1969. Precipitation in 1968 was about 11.9 inches—36% below the long-term average. Low precipitation in 1968 may have resulted in lack of fertilizer response that year. The response of legumes to the full treatment—fertilized and tilled in 1969—appears to be the result of interaction between the two partial treatments. Tilling may extend the time hold-over effects will be obtained.

Although a more intensive study with more replications is needed to test these indications, our data suggest that tilling annual plant rangeland may increase total herbage yields and alter species weight composition. Annual plant rangeland fertilized with sulfur, however, will give higher yields than unfertilized areas in drought years (Woolfolk and Duncan 1962). Gypsum fertilizer, therefore, may be more reliable than tilling to

increase yields. But the full treatment—tilling and fertilizing—may just be better than fertilization alone.

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# Management Program for Leafy Spurge

Daniel L. Noble and Daniel C. MacIntyre

Leafy spurge is a tenacious perennial weed problem on rangelands of the northern Great Plains, with nearly 2½ million acres infested in North America (Noble et al. 1979). This weed, with a distribution center in the Caucasus Region of the U.S.S.R. (Croizat 1945), is distributed across the northern hemisphere from China in the east to the U.S. and Canada in the west. It is found in 25 states in the United States and has reached economic importance in 14 states, with an estimated control cost in 1978 of 10.5 million dollars. Interest in this serious problem is indicated by passage in 1979 of resolutions by both the Montana and North Dakota legislatures and the Old West Regional Commission supporting accelerated research and application programs for development of an integrated pest management (IPM) program<sup>1</sup> to control leafy spurge.

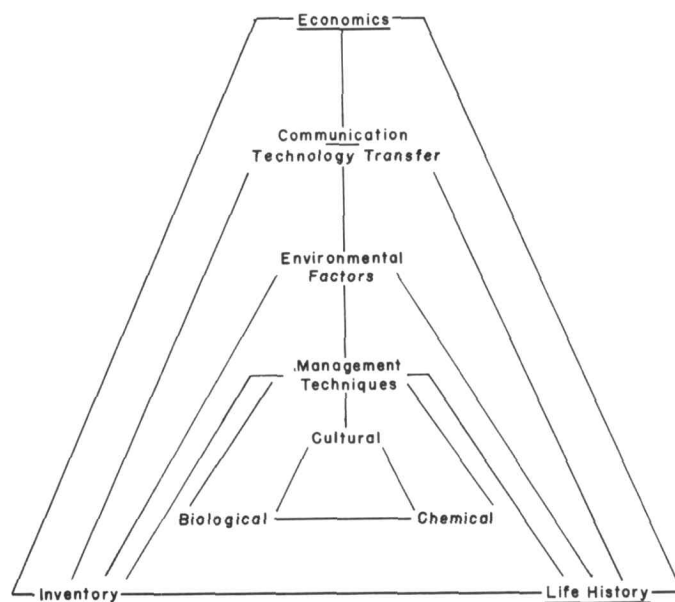
Current control measures for leafy spurge on range and wildlife land depend heavily on herbicides<sup>2</sup>—2,4-Dichlorophenoxyacetic acid (2,4-D), picloram (Tordon), and glyphosate (Roundup). These chemicals are expensive and some infestations are increasing in spite of herbicide treatment. It is not clear whether this is due to leafy spurge tolerance, methods of application, or both. Furthermore, repeated application of these chemicals on rangelands, particularly habitats involving water, may result in confounding environmental problems.

The need for an IPM program which would utilize biological and cultural controls in addition to herbicides is apparent. Also

<sup>1</sup> Noble is ecologist, Rocky Mountain Forest and Range Experimental Station, Research Work Unit at Rapid City in cooperation with South Dakota School of Mines and Technology; Station's central headquarters maintained in Fort Collins, in cooperation with Colorado State University. MacIntyre is forest supervisor, Custer National Forest, with headquarters in Billings, Mont.

<sup>2</sup> The use of trade, firm, or corporation names in this article is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the U.S. Department of Agriculture of any product or service to the exclusion of others which may be suitable.

Although this report discusses research involving pesticides, such research does not imply that the pesticide has been registered or recommended for the use studied. Registration is necessary before any pesticide can be recommended.



An organization diagram showing interrelationships of subject matter for an integrated pest management program.

needed is a reemphasis of range management techniques effective against pests—regulations, early detection and eradication, and maintenance of quality rangeland competitive against invasion from noxious weeds.

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