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SERDP Interim Report 1998

1. Project Title: Identify resilient plant characteristics and develop a wear-resistant plant cultivar for use on military training lands.

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3. Project Background: 6.2 Applied Research/Exploratory Development
Military training installations represent some of the most intensively used lands in the United States. Military vehicular traffic has a very destructive direct impact on the vegetation. Destruction of the vegetation may, in turn, lead to soil erosion, sedimentation of streams and lakes, loss of training realism, and reductions in the carrying capacity of the land. Land rehabilitation measures are needed to mitigate environmental impacts and improve the use of military training lands. There is only limited knowledge on the relationships between military training and plant injury, regrowth, and wear resistance. No plant breeding or selection has been done to increase the wear resistance of plants for military training land rehabilitation. Agronomic research has emphasized the use of introduced species for forage production and turfgrasses. Little attention has been paid to the ability of plants to tolerate conditions typical of military training lands and establish a self-sustaining, low-maintenance vegetative soil cover. One of the limiting factors in developing new plant material is the lack of information on their basic biology and the corresponding traits that make them adaptable to the stresses caused by the Army's mission and land use.

4. Objective:
The overall objectives of this proposal are (a) to breed improved native and naturalized plant cultivars that are more resistant to land disturbances caused by military training activities and (b) to understand the effects of training on soil compaction, plant injury, and regrowth. Plant and soil data will be combined to allow land users to make knowledgeable choices concerning plant selection and site-rehabilitation procedures to reduce soil erosion. The results of this work will provide guidance for mitigation methods and more resilient plant cultivars that will help to increase training opportunities on existing training areas.

5. Technical Approach:
This Project is a cooperative effort primarily with USACRREL and the US Department of Agriculture-Agricultural Research Service. Supporting work will also be performed by Pennsylvania State University, US Army Construction Engineering Laboratory (USACERL), US Army Waterways Experiment Station (USAWES), and Colorado State University. The activities of the proposed research are (a) to identify and develop training-resilient plant cultivars and (b) to conduct field and greenhouse studies to quantify the degree of soil compaction that occurs during training and relate this soil condition to root injury in plants with known resilience.

(a) For plant breeding our approach will be as follows:

1. Initially evaluate plant materials previously established in space-planted breeding nurseries and seeded evaluation trials at Fort Carson, the Yakima Training Center (YTC), and Logan, Utah. Characteristics of major interest will be seedling vigor, tiller and --

rhizome development, resistance to drought and plant pests, growth under cold temperatures, vegetative vigor, and potential for natural reseeding. Seeded evaluation trials will be subjected to controlled disturbances by army vehicles and other training activities.

2. Establish selected clonal and progeny lines from breeding nurseries in second-stage breeding nurseries on the three research sites (Fort Carson, YTC, and Logan, UT). Accessions and cultivars selected on the basis of results from evaluation trials will be included in larger-scale plantings, primarily in mixtures with other species.

3. Following establishment of these perennial plant materials, make more intensive evaluations in breeding nurseries. Attempts will be made to use RAPD technology developed under the BT-25 genetic marker program along with more traditional screening methods to evaluate these plants. Data collected from the second-stage, seeded evaluation trials will be expanded to include resistance to and recovery from more intensive use of actual training activities.

4. Include clones, selected from the second-stage breeding nurseries on the basis of parent and progeny performance, in crossing blocks to produce seed of experimental strains.

5. Subject experimental strains to seeded trials under a range of environmental conditions to identify those for release as improved cultivars. These new cultivars will be used along with those previously identified in the seeded evaluation trials in large-scale plantings on military training lands.

(b) For soil compaction our approach will be as follows:

1. Use cone penetrometers to assess the degree of soil compaction that occurs after training exercises on several training lands.

2. Evaluate the degree of root injury occurring in the field as a result of soil compaction along with any resulting harmful effects on plants' ability to regrow and adapt. Use field data to design and conduct greenhouse studies on interaction of root growth and soil compaction. Relate training intensity to plant injury.

3. Conduct new greenhouse studies to further document the effects of soil compaction on root growth.

4. Conduct field studies to evaluate root growth of new cultivar developed in part (a) in soil-compacted conditions.

5. Use results to determine land rehabilitation requirements.

6. Project Accomplishments:

(a) Plant breeding:

We conducted vegetative surveys at three facilities (Fort Carson, YTC, and Fort Drum) to identify the most promising native and naturalized species and to determine plant characteristics that are important for adaptability in a training land environment. The characters found to be important were seedling vigor, tiller and rhizome development, resistance to drought and plant

pests, growth under cold temperatures, and potential for natural reseeding. Plant materials will be evaluated for these characteristics in the development of the new cultivars. We refer to the introduced species as naturalized since these species are well adapted to the site and have probably been there for over 50 years, going back to when the area was used for civilian ranchland. These naturalized species have co-existed with native flora on these and adjoining sites.

The extensive collections of native and naturalized plants collected during the vegetative surveys were assembled with other clones in first-cycle breeding nurseries at Fort Carson, YTC, and the USDA research facilities in Logan, UT. These plant materials were the genetic foundation our breeding program to develop new cultivars. At Fort Carson and YTC, we also established five seeded evaluation trials that are helping us identify promising germplasm and obtain information to meet future milestones related to plant breeding. The seeded evaluation sites at the facilities differ in soil type and precipitation, which allows for evaluation of germplasm over several different environmental regimes.

Based on evaluation data of seeded and space-planted trials, we selected the following species to carry forward in our breeding program to develop the new cultivars. At YTC, we selected germplasm of the native species Snake river wheatgrass, bluebunch wheatgrass, and Great Basin wildrye and the naturalized species Russian wildrye, Siberian wheatgrass, crested wheatgrass, and forage kochia. At Fort Carson, we selected the germplasm of the native species western wheatgrass, slender wheatgrass, and thickspike wheatgrass and the naturalized species Russian wildrye, Siberian wheatgrass, and crested wheatgrass. New experimental strains, derived from these plant materials, will be included in evaluation trials under a range of environmental conditions to identify those for release as improved cultivars. These new cultivars will be used along with those previously identified in the seeded evaluation trials in large-scale plantings on military training lands.

In August, we prepared an abstract entitled "Breeding resilient plants to rehabilitate cold-region military training lands", which was accepted for presentation at the 6th Annual Integrated Training Area Management Conference (ITAM) held at YTC in August. At YTC, our SERDP evaluation plots were included as a stop during the ITAM field tour. During FY1998 we also released our first germplasm, which was described in the journal Crop Science, and we assisted Fort Carson in developing seed mixtures to repair damaged lands.

(b) Soil compaction:

The degree of soil compaction that occurs after training exercises on several training lands was determined with a cone penetrometer. We made three site visits to YTC and Forts Carson and Drum to determine soil compaction levels. The areas were selected for various degrees of training intensity and included high and low use areas and bivouac sites. Two predominant soil types, including either a sandy or silty texture, were sampled at each facility. The preliminary results showed that the depth of soil compaction was related to land use and soil type at each installation. The finer-textured soils and those with a higher soil moisture content had greater compaction at the soil surface than did the course textured or drier ones.

In FY1998, we began a greenhouse study to develop data sets on root growth in compacted soils. The study was conducted in rhizotrons where the amount of root growth of the grasses can be measured and observed. We used six soils from three facilities (YTC and Forts Carson and

Drum) with three compaction rates for each soil; the compaction rates (high, medium, and uncompacted) were based on the measurements made in the field (see table below). We used 162 rhizotron tubes and planted three grasses with three replications of each treatment. The first greenhouse study was harvested in June and we are now analyzing the data. The plant leaves and roots are currently being measured for their weight and area.

	Compaction Rates (Kpa)		
Installation	High	Medium	Low
Fort Carson	3500	1800	400
Fort Drum	4000	2000	1000
Yakima Training Center	4000	3000	1500

During the year we had four publications (three journal manuscripts and one conference report) and one abstract. The titles were:

Huff, D.R. and A.J. Palazzo. 1998. Fine fescue species determination by laser flow cytometry. Crop Science 38:445-450.

Asay, K.H., D.A. Johnson, and A.J. Palazzo. 1998. Parent-progeny relationships for carbon isotope discrimination and related characters in crested wheatgrass and Russian wildrye. International J. of Plant Science 159:821-825

Jensen, K.B., K.H. Asay, D.A. Johnson, W.H. Horton, A.J. Palazzo, and N.J. Chatterton. 1998. Registration of RWR-TETRA-1 Tetraploid wildrye germplasm. Crop Science 38:1405.

Palazzo, A.J.; K.H. Asay, K.B. Jensen, W.H. Horton, P.E. Nissen, and J.C. Linn. 1998. Breeding resilient plants to rehabilitate cold-region military training lands. Presented at the Seventh Annual ITAM Workshop on Military Land Rehabilitation and Management.

Liu, X.L., R.R. Wang, K.B. Jensen, A.J. Palazzo, N.J. Chatterton, and K.H. Asay. 1997. RAPD and STS markers for fast-germinating western wheatgrass and Salina wildrye. American Society of Agronomy Abstracts. Annaheim, CA.

18. Milestones:

Milestones	Planned date
1. Determine soil compaction rates on training lands at two military facilities	11/30/97
2. Develop data sets on compaction with soil depth in various types of training areas	09/30/98
3. Complete evaluation of first-cycle breeding nurseries and evaluation trials	06/30/98
4. Initiate second-stage seeded evaluation trials	09/30/98
5. Provide interim report	12/30/98