CHAPTER VII

SUGGESTIONS FOR ADDITIONAL RESEARCH

Verification Trials for Prototype Injection System

When a prototype injection system is built, it will be necessary to run a series of organized trials to (1) test the system, (2) verify the production rates that were assumed for the design, and (3) optimize the design of the subsoiler and its injection ports. While much of the system can be tested in the fabrication shop, the actual deposition of material can be tested only in field trials. Recognizing that there would be any number of frustrations associated with inaugurating a new system, the tests recommended here are for a working prototype that has had the initial faults worked out.

Field trials will be needed merely to determine methods of refilling the hopper while in motion. As these trials are underway, it will be possible to measure deposition rates and compare them with the design capacity. If less than the design rate is found, it will be necessary to diagnose the constraint: machinery or subsoiler-soil interface. An appropriate step will be to dig out a portion of the disturbed zone to see clearly the distribution of the injected material.

Each trial, therefore, should monitor continuously speed of the tractor and feed rates through the injector. Delays and their causes should be noted. Confirming measurements should be taken such as length of ripped zone and total amount of material injected. Additionally, turn times at the end of a row should be measured and time to refill the hopper should be measured.

Subsoiler

The maximum amount of material that theoretically may be deposited into the ripped zone is dependent upon the size of void that is created. Any disturbance to the soil will provide a dilatant effect, which is an increase in void ratio in the soil. Injection, however, will occur only in the macro-voids that are on the failure surface derived from the cutting shoe. It is presumed that these macro-voids are dependent upon the geometry of the subsoiler. While the size of the overall disturbed zone is a function of depth of cutting, the macro-voids are a function of the shape of the cutting foot.

Many different shapes have been tried in tests of deep tillage machines. However, no tests are known where the intent was to increase the size of void at the base of the crescent failure zone. Consequently, a suggestion for further research is to try different types of subsoiler feet to see if production rates can be enhanced.

Additionally, the prototype design presumes that two injection ports, one at each wing, would be effective. This presumption needs to be tested; for example, would an horizontal slot be more effective than circular ports? It is also presumed that air will return preferentially through the vertical slot and that, as a consequence, there is no need to inject material into the slot itself for it will fill easily. This presumption, too, needs to be tested. Digging out the fill zone, as suggested above, will reveal where the injected material is going. If it is not reaching the vertical slot, then other port arrangements will be needed.

Material Trials

It is expected that the prototype injection system will have been designed with a particular waste material in mind, most likely chopped straw. Nevertheless, additional materials should be tried to determine the versatility of the design. Field trials would concentrate on disposal rates for some or all of the following materials: silage, corn stalks, food processing wastes, animal wastes, and sterile sewage sludge.

For the sake of developing production characteristics, minimum and maximum disposal rates should be developed for each material. This implies that speed and feed rates should be varied until maxima are established. Inasmuch as zero is an easy and trivial target, a minimum rate implies the least amount that can be delivered while still maintaining an uniform flow.

Recompaction

Some trials should be aimed at creating deliberate recompaction to see if the benefit that was seen in the laboratory tests can be seen in the field as well. This implies ripping some zones with injection and then some without. Both zones would be subject to similar amounts of machinery movement after they were ripped. The Giddings soil probe or the nuclear density gauge would be used to measure the recompacted density.

Crop Yields

Once an effective injection system is available, long-term trials for crop yield should be established. Corn is the crop most sensitive to deep compaction and should, therefore, be planted in, at least, a five-year succession on sufficient test and control plots to assure replication of results. Only normal tillage practice would be performed during the period of the trial.