Figure 6.1 A cold tolerant cereal such as triticale planted by early September can provide sufficient cover with good irrigation management for wind erosion control through the fall and over winter.

Figure 6.2 Cereal cover crop being grazed by sheep, which demonstrates the forage value of triticale and winter wheat during fall and winter.
not provide adequate surface cover and/or roughness when the soil is dry and high winds occur. The objectives of the BMPs are to 1) establish and maintain vegetative cover on the land, 2) maintain clods and roughness in combination with vegetative cover, especially if vegetative cover is lacking, 3) use vegetative barriers and strip cropping for added protection, and 4) apply emergency control measures when the soil is inadequately protected during periods of high erosion potential.

Main Problems in Need of Attention

Some of the main situations which cause concerns with wind erosion on irrigated lands are as follows.

Late fall harvested crops. These primarily include root crops such as onions, carrots, sugar beets, and late potatoes which are harvested in October or November after the weather cools. Such crops produce low amounts of above-ground dry matter, much of which is readily decomposable and/or covered by the harvesting operation. Cool weather after harvest often precludes establishing a cover crop before winter. Without protection, these fields are subject to blowing until cover is established in the spring.

Low residue crops. These include row crops such as dry beans, sugar beets, onions, potatoes, and most vegetable crops that produce relatively small amounts of above-ground residue that generally decay rapidly. The lack of residue cover after these crops are harvested leaves the soils vulnerable to wind erosion until the next crop is established.

Excessive tillage. Repeated, aggressive tillage is often used to take out hay crops such as alfalfa and grass for seed production, or to breakdown and bury cereal or corn residues in preparation for sowing a row crop. Such tillage often destroys soil structure and exposes bare soil to winds. Aggressive tillage tools include heavy double discs and disc packers, moldboard plows, and rotovators. Lighter implements for secondary tillage, including field cultivators and harrows for smoothing the soil surface, can also contribute to loosening and pulverizing the soil and making it more susceptible to wind erosion.

Lack of cover and roughness following spring planting. Major wind erosion can occur after spring planting because 1) extensive areas are tilled leaving the surface soil bare and smooth (and intermittently dry) for several weeks until crop cover is established, and 2) spring planting coincides with a critical period of increased probability of strong winds. Dust storms at that time can result in severe crop damage forcing growers to replant and extensive erosion from soil saltating across unprotected fields. Road closures in local areas from blowing dust are also common.

The following BMPs address most of these erosion hazards.

Management of Cover and Roughness

Cover crops

Cover crops have the potential to control wind erosion after single season crops which leave little residue for protecting soils from fall until early spring (Figure 6.1). No-till planting can extend the benefits of cover in some cases through spring planting until the next crop is established. In addition to wind erosion control, cover crops can also reduce water erosion, improve soil structure, maintain and build soil organic matter, enhance soil fertility, suppress plant pests, reduce nitrate leaching, and provide forage for livestock.

A fall-seeded crop to provide full ground cover should be planted between early September and mid-October with proper irrigation management to obtain sufficient growth for protection against wind erosion. Spring establishment is also possible provided the crops are planted early. February is generally a good month to seed for early spring plant establishment. Cereals such as triticales
and winter wheat are good choices for overwinter cover because these species can tolerate and survive cold weather. However, spring wheat which has less cold tolerance can produce cover more quickly than triticales and winter wheat after sowing and therefore is a good candidate for fall and early spring cover. Experiments conducted by Washington State University showed that spring wheat produced 80-percent ground cover by 3 weeks after planting compared with approximately 20, and 20 to 40 percent for winter wheat and triticales, respectively (see Table 3.6). The potential for wind erosion with a 50-percent cover and low surface roughness is less than 10 percent of that for bare soil (see Table 4.1) and is adequate protection for most fields.

In addition to good erosion control, the cereal cover crops have the potential to produce high quality livestock feed with crude protein and digestible nutrient levels similar to oat grain (Figure 6.2). Triticales can produce significantly more forage than wheat in the spring, but more similar amounts in the fall. Forage cover crops, such as Sudan Grass, can compete well with weeds (Figure 6.3), and can absorb and store substantial quantities of residual nitrate which helps to protect water quality.

Under irrigated conditions, the erosion control benefits of a fall or early spring seeded full cover crop can be extended by using no-till to establish the spring cash crop in the residue of the cover crop killed by herbicides. An array of crops can be planted without difficulty into the dead residue in a one-pass operation using a variety of available drills are readily available for no-till planting. However, it is essential to obtain sufficient dry matter production before the cover crop is chemically-killed to ensure adequate cover for wind erosion control. An effective height of about 8 inches is usually recommended for close-growing cereals before herbicide kill. All of the plants can be sprayed or just in strips. Strip kill leaves effective green barriers for protecting the new crop. These can be especially effective for protecting high cash value crops such as onions, carrots, and celery which have small seedlings that are vulnerable to damage during wind erosion events.

A spring-seeded companion cover crop is an alternative approach to cover crop management. Small grains are seeded at a low rate at the time of planting a broadleaf crop such as beans. The grain cover establishes more quickly and can be killed with herbicide just before the bean crop emerges or after the crop is established with a directed spray. A variation of this method is to no-till plant the crop (e.g., beans) into the growing grain cover. This practice has shown promise in recent research. However, management requirements are not fully understood and will need further study. Small grains and legumes are most commonly used for cover crops; however, several other plant species and varieties offer potential as cover crops including mustards, Sudan grass, canola, and turnips.

The objective of crop residue management for wind erosion control is to maintain a protective cover of crop residue throughout the critical erosion period when there is no growing crop cover. This includes the period from planting until the new crop has attained sufficient growth to control wind erosion (Figure 6.4).

**Minimum tillage.** Surface residue is conserved by reducing the number of tillage operations, and using implements and/or tools that leave most of the residue on the surface (Figure 6.5). Implements such as undercutters and sweeps that sever roots and lift weeds without burying or destroying much of the residue are most efficient for maintaining surface cover. Where residues are excessive such as following a heavy wheat crop discing to mix a portion of the residue with the soil may be necessary to prepare a seedbed for a row crop. Moldboard plowing, which can bury over 90 percent of the residue, should be avoided.

Research at Kimberly, Idaho, has shown that cereal stubble could be...
successfully managed without moldboard plowing for the production of irrigated dry beans and sugar beets. One or two discings in the fall, followed by one or two discings in the spring mixed enough of the residue with the soil so that only about two roller harrowing operations were needed to prepare a suitable seedbed for these crops. When dry beans, sugar beets or cereal crops followed dry beans or sugar beets, one roller harrowing was adequate to prepare for planting.

A minimum tillage system to conserve surface cover was developed by a Columbia Basin grower for Quincy fine sand. The operations when planting corn after corn or wheat after corn is to chisel, disc and plant. To rotate from corn to potatoes the field is chiseled and disced in the fall, and then disced once and planted in mid-April. The time from spring discing to planting should be only a few days or less. This minimum tillage system has effectively reduced the number of tillage operations compared with the traditional system, and has significantly increased the levels of surface cover. In the future, this same grower will be planting triticale for pasture after wheat. Following a cutting of hay in May the field would then be planted to sweet corn. This system should provide adequate soil protection from wind erosion during the critical spring period.

Judicious use of herbicides and crop rotations are important to the success of minimum tillage systems. Crop rotations not only break weed cycles but also the life cycles of crop specific plant pathogens and insects. The amount of residue production over time can also be controlled through crop rotation by sequencing high- and low-residue producing crops. In addition to wind erosion control, the benefits of using a minimum tillage system on irrigated farms according to grower’s experiences can be summarized as follows:

- up to 30 percent time savings
- lower fuel costs
- less maintenance on tillage equipment
- no loss in yields
- no loss in crop quality
- soils have greater water holding capacity

The additional costs are:
- higher pesticide use
- more maintenance when in alfalfa due to rougher fields
- more time needed for management

**No-till.** Maximum surface residue retention and conservation can be achieved with low disturbance no-till, i.e., using drill openers that only minimally disturb the soil in placing seed and fertilizer (Figure 6.6). Research at Kimberly, Idaho on furrow irrigation systems showed that winter wheat and corn could be successfully grown by no-till when seeded into killed alfalfa sod. The alfalfa was killed with herbicide in the fall after sufficient re-growth had occurred following the third cutting of hay. Winter wheat was seeded almost immediately following application of herbicide on the alfalfa. Seeding was done parallel to furrows with regular irrigated-land drills. The same furrows used to irrigate the alfalfa were cleaned the following spring and used to irrigate the wheat. With corn, the alfalfa was killed with herbicide in the fall and corn was seeded in the spring. A cutting coulter or chisel point was used ahead of each seed opener to ensure proper seeding depth. Furrow management was the same as for winter wheat.

Other crop sequences that could be successfully grown with no-till on furrow-irrigated land included cereals following corn, corn following cereals, and corn following corn. In all of these studies, crop yields and quality were similar to those produced with conventional tillage methods. Production costs with no-till were considerably lower than for conventional tillage. In some cases there were difficulties with no-till from excessive residues; for example, when corn followed a high yielding wheat crop. Depending on the equipment, the removal of some wheat straw may be required to ensure successful no-till planting of a row crop.

It has long been recommended that hay and pasture crops of legumes and grasses should be planted by no-till. If necessary, excess residues should be removed and the seeding made directly into the remaining stubble. Weeds should be controlled by selective herbicide if necessary. On sandy soils with low residue, a nurse crop such as spring wheat should be established prior to no-till seeding of alfalfa or pasture.

**Residue management under sprinkler irrigation.** Tillage is often used to fracture impervious or compacted soils, thereby increasing infiltration for sprinkler irrigation and reducing runoff and water erosion. However, the beating action of the water drops soon breaks down the soil structure and causes surface sealing. Surface residues help prevent sealing by absorbing the energy of the falling water drops. The presence of surface residue also encourages earthworm activity which produces burrow holes or channels through crusts and the dense surface layers connecting to the more porous underlying soil. These benefits of surface residue help keep infiltration more uniform and decrease water erosion. Moreover, the surface residue simultaneously helps to control wind erosion as well.

According to research at Kimberly, Idaho any residue management practice...
that can be successfully applied for dryland agriculture can generally be applied for sprinkler irrigation. Crop residue can be more easily managed on the soil surface with sprinkler irrigation than with surface irrigation. The primary argument for tillage under sprinkler irrigation has been to provide for sufficient seed-to-soil contact for proper seed germination. A light irrigation can generally accomplish this objective. Crop rotations and sequences recommended for furrow-irrigated land should also be successful under sprinkler irrigation.

**Wind erosion control with low residues**

An evaluation was made by the Franklin Conservation District of practices for controlling wind erosion and blowing dust from low residue producing crops that are clean-till planted in the spring and late harvested in the fall. These cropping systems are of particular concern because of the wind erosion hazard in the spring after planting and again in the fall after harvest. Crops in this category include potatoes, onions, sugar beets, carrots and beans.

The objective of the control practices was to obtain different levels of roughness and/or cover for comparison with a no-control treatment. The treatments were evaluated in growers fields for two seasons. BSNE dust collectors (see page 12) were placed in plots to collect eroding soil particles for evaluating treatment effects.

**Control practices for the fall.** Potato was chosen as the representative crop. The crop was harvested in mid-October after which only a few hundred pounds of dry matter per acre remained on the soil surface. Treatments were as follows.

- Disc/pack
- Bed/ridge after disc/pack
- Crustant (molasses base)
- Disc/pack, seed grain
- Ridge/pit after disc/pack
- Wheat straw (1000 lb./acre) and disc to anchor after disc/pack
- Grain, no-till seeded
- Disc/pack and pit (dammer-diker)
- Ripped
- Check, left as is after harvest

The results presented in Figure 6.7 show that when wheat straw was spread and anchored after harvest it provided the best fall wind erosion control. While it is an expensive remedial measure (Figure 6.8) it is feasible for treatment of critical areas (e.g., “blow” spots) of the field to prevent serious large scale wind erosion. Soil with maximum roughness from ridging and pitting provided the next best control (Figures 6.7 and 6.9). A ripper (chisel implement) used on frozen ground was almost as effective as the aforementioned treatments in the fall of 1995 mainly because it produced large clods that were stable overwinter.

Other treatments that produced roughness provided some degree of control. These included disc/pack and pit, and bed/ridged. The molasses-based soil crustant (i.e., a commercial soil binding agent) was less effective than most other
Best Management Practices For Irrigated Farms

treatments and is expensive. Late seeded grain (disc/seed) which usually provides limited cover overwinter produced varied results. Nevertheless, seeding a cover crop is a well-accepted practice by growers and the green growth early in the spring makes it a good option if a late planted crop, like corn or beans, is next in the sequence.

A one-season study on fall wind erosion control following low residue cropping was conducted by the Soil Conservation Service (now the Natural Resources Conservation Service). Results showed that a fall-bedded treatment (comparable to bed/ridge after disc/pack) retained considerably more roughness overwinter than either disc/pack or a late-seeded grain cover crop. Based on dust collection over the critical wind erosion period, fall bedding was superior to disc/pack, and the cover crop was intermediate in effectiveness to these two treatments for controlling wind erosion.

**Control practices before spring seeding.** Spring control practices applied in conjunction with the hill (ridge) produced by planting potatoes were:

- **Crustant** (a soil binding agent: molasses-based in 1995 and bentonite-based in 1996).
- **Grain broadcast** before potato planting.
- **Pitted** after potato planting (with dammer diker).
- **Wheat straw** (1000 lb./acre) spread before potato planting.
- **Check**—left as is after planting.

Evaluations based on the dust samplers indicated that wheat straw spread prior to planting gave the best control of wind erosion in the spring (Figure 6.10). The straw treatment is simply the addition of supplemental surface residue. Thus, if the previous crop was a high residue or cover crop, proper tillage management to preserve the residue would help to control erosion and likely be cost-effective (see previous section on “Crop Residue Management”). If the straw must be imported it is only practical to apply it as an emergency remedial measure. Pitting (in addition to the potato hills) was also effective in controlling wind erosion.

Grain broadcast prior to potato planting produced only enough green cover to allow a small reduction in erosion. However, the cover crop practice is readily acceptable to growers. Results from the crusting agents were about the same as grain cover; however, because of their cost the use of crusting agents would likely be limited to situations where protection of the emerging crop is critical.

**Approximate costs.** The following are per acre cost estimates associated with the various treatments to control wind erosion under low residue conditions on irrigated farms.

- **Straw:** $20 for 1000 lb. straw, $10 to apply, $10 to anchor in fall, with no anchor cost in spring (done by planter).
- **Crustant:** Molasses-based, $30-$35 plus $5 application; bentonite-based, $20-$25 plus $12.50 application (requires agitation during application) (spring or fall).
- **Pitted/hill:** $10 to disc/pack and $15 to pit/hill (with dammer-diker) in fall; $10 to pit in spring since hills already formed.
- **Bed/Ridge:** $10 to disc/pack and $10 to bed in fall.
- **Disc/pack and pit:** $10 for disc/pack and $10 for pit, as fall operation.
- **Grain, disc/pack and drill:** $10 per pass with implements (one or two passes) and $5 for seed as fall operation.
- **Ripped:** $15 for rip plus $10 if disc/pack necessary first—$17.50. Weighted average for fall.

![Figure 5.14 Photograph of “pits” in a bare, tilled field.](image)

![Figure 6.10 Approximate costs of implementing fall and spring wind erosion control practices.](image)
• Grain (no-till, broadcast): $10 to no-till drill plus $5 for seed in fall, and $5-$10 for broadcast or fly plus $5 for seed as spring operation.
• Disc/pack: $10 for one pass with implements in fall.

Several conclusions from these studies are as follows. In low residue situations, practices that promote cover and roughness should be implemented by growers who are experiencing blowing dust problems in the spring and fall/winter when unprotected soil is vulnerable to wind erosion. Conserving the existing crop residue using minimum tillage and no-till is the best way to manage the residue. Adaptable cover crops, if planted early, can be highly effective for erosion control, and growers are generally receptive to using this practice.

Vegetative Barriers and Strip Cropping

Small grain or grass barrier strips
Vegetative barriers may consist of perennial or annual plants with erect growth habit planted in single or multiple rows perpendicular to the direction of the prevailing winds, to reduce erosion and crop damage from wind-blown sand.

These vegetative strips can reduce wind erosion rates by up to 25 tons per acre per year as well as emissions of dust particulates. Of particular interest to growers are the use of narrow rows of small grains such as oats, barley, triticale or wheat planted in the spring or fall to protect seedlings of vegetable crops such as carrots, onions, beans, sugar beets and potatoes (Figure 6.11). Ideally, the barrier plants should have some degree of cold hardiness if the protection is needed through the winter e.g., for a late summer-seeded carrot crop. These protective strips must be re-established each year and may require additional management for maintenance such as fertilizer application and weed control.

The strips are established by sowing with single-grain drill openers with seed box attached to a vegetable planter or other implement. Spacing intervals are adjustable and will vary according to the crop grown. For example, with onions, single row small grain barrier strips are planted 88 inches apart with 4 onion beds in-between. The strips can easily be sprayed with herbicides after the critical erosion period is over. NRCS specifications for vegetative barriers consider such factors as barrier height, row direction, and plant density or barrier porosity for maximum effectiveness. The costs of establishing the barrier strips have also been determined and are usually shown to be economically feasible.

Strip Cropping

Under irrigation, large, open fields with highly erodible soils, especially if sown to row crops, can be particularly vulnerable to wind erosion. Dividing the field into strips alternating vulnerable areas with resistant crops can afford good protection against wind erosion for the whole area. Crops should be selected so that the whole field is not left unprotected at any time during the critical wind erosion period.

Erosion control is maximized if the strips are at right angles to the prevailing winds. For greatest benefits, strip cropping should be used in combination with other erosion control strategies such as crop residue management, cover crops and surface roughness. In most cases farming in strips should work well with surface (e.g., furrow) irrigation systems. However, it may not always be practical with sprinkler irrigation, especially with center pivot irrigation systems because the different crops must be irrigated in the same way under a single system.

Sources of Information and Suggested Reading


Soil Conservation Service Conservation Practice Standard
a) Surface roughening WA 609. 6/1989
b) Conservation cover WA 327. 2/1993
c) Cover and green manure crop WA 340. 9/1986
d) Conservation crop rotation 328. 6/1994
e) Cross wind ridges 589A. 6/1994
f) Residue management, seasonal 344. 6/1994
g) Mulching 484. 7/1988
h) Cross wind trap strips 589C. 6/1994
i) Herbaceous wind barriers 422A. 6/1994
