A Tree Planter’s Guide to Reducing Musculoskeletal Injuries

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Introduction

Musculoskeletal injuries (MSIs) are one of the most troublesome injuries that persist in other-wise safe industries with excellent safety programs. Common MSIs include tendonitis and other repetitive and muscle strain injuries. MSIs, such as a back muscle strain, can occur suddenly. They can also develop gradually from over-exposure to commonly accepted MSI risk factors such as force, repetition or awkward postures.

About one third of the WorkSafeBC (Workers’ Compensation Board of British Columbia) injury claims submitted in the tree planting and cone picking category from 1997 to 2001 were classified as overexertion or repetitive motion accidents. Tree planters in particular are exposed to repetitive motion which in general accounted for 54% of the days lost for all industries from 1983 to 2002. During this time an average of 88 claims per year were made by silviculture contractors for repetitive motion and overexertion. Wrists and fingers accounted for 20% of all claims and backs accounted for 15%.

The shovel is coded by WorkSafeBC as a source of injury, and accounted for 14% of all tree planting and cone picking claims from 1996 to 2000. Repetitive motion and overexertion accidents were specified for 89% of all shovel-related claims. Tree planters are predisposed to injuries because their work is hard and repetitive in nature. These ergonomic guidelines are aimed at helping the planters stay healthy.

Tree planters should know how to practice safe work procedures and how to select appropriate equipment, while planting contractors should have safety guidelines that minimize the MSI risk factors. This knowledge can help reduce costs from injury and time away from work for first aid or medical aid, and recovery. A positive attitude towards health and safety also contributes to the phychosocial well-being of employees.

A musculoskeletal injury (MSI), as defined by WorkSafeBC, is an injury or disorder of the muscles, tendons, ligaments, joints, nerves, blood vessels or related soft tissue including sprains and inflammations, that may be caused or aggravated by work. It includes overuse injuries such as tendonitis as well as overexertion injuries such as muscle strain.

Ergonomics is the study of human abilities and characteristics that affect the design of equipment, systems and jobs.
In the tree planting occupation, the opportunity to apply typical ergonomic solutions is severely limited. In other occupations, such solutions include engineering or workstation design changes, administrative changes such as task rotation, or job changes such as job enlargement (i.e., adding other tasks). Tree planting supervisors should therefore be aware that hours worked, expected daily planting rate and tasks may need to be adjusted to help rookie crews and individuals manage soreness and fatigue. As well, it is important to identify aspects of work technique and equipment fit that impact MSI risk factors. Having a dedicated trainer that can teach rookie planters the correct techniques while they work at a fixed day-rate would allow them to be trained without the added pressure of having to “make money”.

These ergonomics guidelines are written for tree planters in western Canada and their supervisors with the aim of reducing MSI. The data supporting the following guidelines were collected during a tree planting research study conducted in 5 locations in western Canada involving 135 tree planters. Tree planters in eastern Canada may also benefit from this information, although the different planting tools used there have not been analyzed in this project.

**Signs and Symptoms of MSIs**

It is important to recognize the early signs and symptoms of MSIs so that treatment can be sought quickly and steps taken to avoid further risks.

**Signs that can be observed are:**
- Swelling
- Redness
- Difficulty moving a particular body part
- Tenderness along the course of the tendon
- Crepitus (leathery creaking sensation; in a joint it can represent cartilage wear in the joint space)

**Symptoms that can be felt but cannot be observed are:**
- Numbness
- Tingling
- Pain

**If you are experiencing signs and symptoms of MSI:**
- STOP - Do not try to “tough it out”!
- Inform your supervisor and follow her/his advice on proper action to take (e.g., modify/change planting technique and pace)
- Report to first aid
- Visit your family doctor, if necessary
What Are MSI Risk Factors?

MSI risk factors are the aspects of a job or task that impose biomechanical stress on the worker. Exposure to MSI risk factors in the workplace can cause or contribute to the risk of developing MSIs. The following MSI risk factors are most likely to cause or contribute to MSIs when combined:

1. Force (i.e., forceful exertions including dynamic motions)
2. Repetition
3. Awkward postures
4. Static postures
5. Contact stress
6. Vibration
7. Cold temperatures

These risk factors are described briefly below:

1. **Force**
   Force refers to the amount of physical effort required to accomplish a task or motion. Tasks or motions that require application of higher force place higher mechanical loads on muscles, tendons, ligaments and joints. Tasks involving high forces may cause muscles to fatigue more quickly, and may irritate, inflame, strain and tear muscles, tendons and other tissues.

2. **Repetition**
   Repetition refers to performing a task or series of motions over and over again with little variation. When motions are repeated frequently for prolonged periods (e.g., every few seconds for several hours), fatigue and strain of the muscle and tendons can occur because there may be inadequate time for recovery. Where task cycles are short, the same muscles are in constant use and the muscles get no rest from the force required to perform the task cycle.

3. **Awkward postures**
   Awkward postures refer to positions of the body (e.g., limbs, joints, back) that deviate significantly from the neutral position. Neutral posture is the position of a body joint that requires the least amount of muscle activity to maintain. Awkward postures often are significant contributors to MSIs because they increase the required work and muscle force.

4. **Static postures**
   Static postures (or “static loading”) refer to physical exertion in which the same posture or position is held throughout the exertion. These types of exertions put increased load or forces on the muscles and tendons, contributing to fatigue. This occurs because not moving impedes the flow of blood needed to bring nutrients to the muscles and to carry away the waste products of muscle metabolism.

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1 For more information, go to: http://tinyurl.com/h50e
5. **Contact stress**
Contact stress results from occasional, repeated or continuous contact between sensitive body tissue and a hard or sharp object. Contact stress commonly affects the soft tissue on the fingers, palms, forearms, thighs, shins and feet. If this contact creates pressure over a single area of the body (e.g., wrist, forearm), it can inhibit blood flow, tendon and muscle movement and nerve function.

6. **Vibration**
Vibration is the oscillatory motion of a physical body. Localized vibration, such as vibration of the hand and arm, occurs when a specific part of the body comes into contact with vibrating objects such as a powered hand tool. Mechanical shock refers to an acceleration that is much greater than the background vibration level, and is caused by a sudden impact between the body (for example hand) and a solid object (for example tool handle). Mechanical shocks result in high forces and contact stresses.

7. **Cold temperatures**
Cold refers to exposure to excessive low temperatures when performing work tasks. Cold reduces the dexterity and tactile sensitivity of the hand, and can reduce muscle strength and increase fatigue. Cold also reduces blood flow to the hand. Because the fingers have a large surface-area/mass ratio, they are particularly susceptible to cold injury and need proper protection. Cold is a problem in combination with other risk factors. It is especially problematic when present with vibration exposure, e.g., when planting in hard, rocky ground. Cold temperature is a risk factor that can be mitigated by having warm, dry clothing available in case of abrupt weather changes, common during the planting season. Having proper clothing and boots for planting work is very important.

**Summary**
Exposure to one MSI risk factor may be enough to cause or contribute to an MSI. For example, a job task may require exertion of such high physical force that even though the task does not involve additional risk factors such as awkward postures or repetition, an MSI is likely to occur. However, MSI risk factors usually act in combination to create a hazard. Of these risk factors, the combination of force, repetition and awkward postures, especially when occurring at high levels, are most often associated with MSIs. Thus, MSI risk factors need to be considered in light of their combined effect in causing or contributing to an MSI.

**Other Factors Contributing to MSIs**
Other contributing factors are the shift schedules, number of hours worked per day and bag-up strategy. Non-occupational components, such as general health, in addition to sports and other physical leisure activities, can also contribute to the development and occurrence of MSIs.

The listed risk factors occurring outside of paid work may also contribute to musculoskeletal injuries.
How to Use this Guide

The information provided in “What are MSI Risk Factors?” should be kept in mind while working as it will help you, the tree planter, reduce your MSIs. Consider then the steps in the “Planting Cycle”, described below. The information in the section “Planting Guidelines” follows the steps of the planting cycle and shows the movements involved in carrying out each step. Pictures illustrate the “Do’s (✔️) and Don’ts (❌)” for each movement. These safe work procedures will reduce the awkward postures and force risk factors.

The “Equipment Guidelines” section shows how the planting equipment affects the postures and offers tips for choosing shovels and bags. The simple activities described in “Warm-up Exercises” will help planters get ready for the day’s work, and “Exercises for Injury Prevention” show exercises that can be done regularly during the work day to prevent muscle imbalances from developing. They will also keep joints flexible and enhance proper body mechanics. In the section “Additional Information” you will find information on other important issues that will affect your health during planting. Ergonomic terms, including neutral and awkward postures for the different body parts used when planting, are explained in the “Glossary of Ergonomic Terms.”

The Planting Cycle

For the purpose of illustrating the different movements made by the planter, the planting cycle has been divided into seven separate elements:

1. Selecting the spot
2. Screeing (when required)
3. Retrieving the seedling
4. Penetrating the soil
5. Opening the hole and inserting the seedling
6. Closing the hole
7. Moving to next spot

The Planting Guidelines provide details for each of these seven steps.

Planting Guidelines

Remember to always use fluid motions and to avoid extreme postures!
1. Selecting the Spot

- Use travel time to relax your grip on the shovel.
- Avoid directing the shovel before you have determined the spot as it tenses the muscles unnecessarily.

- Position your body for the spot.
- Do not overextend to reach the planting spot.

- Learn to recognize good spots based on vegetation and ground contours.
- To avoid hitting rocks and roots causing impact shocks probe lightly, until a suitable spot is found.
- Be aware of the ground conditions, e.g., rocks, stumps, compact soils.
2. Screefing

- Screef only when necessary.
- Use visual cues to identify suitable spots. Microsites closer to large objects such as stumps and logs tend to be easier to screef than areas out in the open.
- Try to avoid boot-screefing the planting spot.
- Using the shovel for screefing the planting spot, alternating the screefing side, is less stressful than boot-screefing.

Caution: Boot-screefing creates impact forces around the knee which can be harmful. Caulked footwear is prone to catching on solid or enmeshed objects in the ground, adding to the force.

3. Retrieving the Seedling

- Keep elbow within 60° from the side of the body—comparable to putting your hands on your hips.
- Adjust the bag setup so elbow does not have to be raised.
• Keep arm within 20° behind the body.
• Position the seedlings in the bag so that the tops are pointing slightly backwards—this facilitates retrieval of the seedling at the root collar level.

• Keep the wrist as straight as possible.

• When planting one species only, avoid looking at the seedling.
• Avoid, as much as possible, rotating the forearm.
• Grip the seedling loosely by the root mass.
• Do not over-grip with the thumb and little finger.

4. Penetrating the Soil

• Keep the elbow within 60° from the side of the body.

• Keep the shovel hand below head height.
• When possible, such as in softer ground, use elbow motion instead of shoulder motion when penetrating the soil.

• Aim the shovel to the front and center of the body.

A well placed hole reduces twisting of the body when inserting the seedling.
When landing the shovel:

Land the shovel with the elbow bent at approximately 120° and with the wrist straight.

Elbow and wrist postures are neutral.

Elbow posture is good but wrist posture is awkward.

Elbow and wrist postures are awkward.

Keep wrist straight, i.e., in a neutral position.

Use a “let-go” technique to reduce shock impact in the hand and arm.
Loosening the grip of the handle as the shovel hits the soil will reduce the shock and vibrations transmitted through the hand and arm. In hard ground, use the foot kicker on the blade to push the shovel into the ground. Although these are good techniques to use to reduce the severity and number of impacts that your arm receives in the planting day, you should keep your wrist posture neutral (see illustration in glossary) and minimize repeated force to the foot and leg.

Penetrate soil with the body as upright as possible:

Plant uphill.  
Plant high spots if that is allowed.

Avoid excessive bending of the low back. Bending beyond 60° puts more stress on the spinal ligaments and increases the shear forces at the spinal joints, increasing the risk of injury. Bend at the knees if possible and keep back strait. Use shovel as support when bending more than 60°.

In hard and rocky ground use the kicker on the shovel instead of hand force:
5. Opening the Hole and Inserting the Seedling

- Make a hole big enough for the seedling and the seedling hand, but not so big that extra work is required to close with the shovel or with the fingers—this is especially important in compact soils.

- Do not push the seedling into a hole that is too small for your hand.

- Keep shovel wrist neutral when opening the hole.

- Bend knees to reduce strain on the lower back when bending forward.

- Reaching forward while bending is more stressful to the lower back than keeping the trunk close to the hole.
Approach the hole symmetrically to avoid twisting or over-using one side of the body:

- Minimize twisting when pulling the shovel out of the hole—more of a problem for planters with D-handled shovels.

The spine is weaker and less able to resist stress in a rotated (twisted) posture. Thus workers are more susceptible to back injury when the back is twisted.

- To reduce twisting, hold the shaft of the shovel if bringing the shovel straight up out of the ground, or bring the shovel backwards instead of up.
6. Closing the Hole

- In soft soils, use light force if you close hole with seedling hand, or use your fist.

Beware of creating air pockets when using hand closure.

- In harder ground, use back blading with the shovel or a light press with the boot to close the hole.
- Alternate with using hand closure.

Beware of scarring the bark of the seedling.
• Keep elbow close to body and wrist straight when leaning on shovel to close the hole.

• Limit the rotation of the shovel forearm when using the shovel to close the hole in order to avoid moving into an awkward posture.

7. Moving to next spot

• Look up before standing up to assist the spine into neutral posture.

• Relax grip on handle while moving between spots.

• Don’t stay crouched when moving from planting spot to planting spot.
Equipment Guidelines

Shovels

Length

- When standing upright, with your arm straight down by your side, the top of your D-handle shovel should be between your fingertips and wrist.
- Staff handle lengths should be no higher than shoulder height when the planter is standing upright.

Shovels that are too long make shoulder posture worse, especially when planting on sites above foot level on steeper ground.

This is the appropriate shovel length for most planters and conditions, and reduces risk of MSI.

Shovels that are too short make back posture worse, especially on flat ground.

Consider keeping shovels of varying lengths and types for different conditions (e.g., steep / flat ground). Some shovels have exchangeable parts — handle, shaft, and blade which allows you to adjust the shovel to the conditions at hand.
Weight

Lighter weight shovels are easier to lift thousands of times each day:

- Hollow shovel shafts, such as those made of fiberglass, are lighter than solid wood shafts.
- Blades also add to the weight and new blades can be cut to the approximate size of the planter’s hand.
- Shovels should weigh less than 1.5 kg.

Keep at least one kicker on the blade for use needed, e.g., when using a lighter shovel on hard ground.

Handles

Staff  Standard D  Ergo D  Oval D

Using D-handles may result in better shoulder and wrist postures than when using staff handles but staff handles reduce shock in the hand and arm. Since the goal is to minimize force and awkward postures, D-handles are good to use when repeated force and shock impact are not concerns, such as when planting in softer ground.
D-handles

- When using this type of handle (Standard D, Ergo D, or Oval D), keep the shoulder and wrist postures neutral.
- Try to keep your elbow within 60° of the side of the body when penetrating the soil.
- Make sure the wrist is neutral when gripping the shovel handle, e.g., when penetrating the soil, opening the hole and closing the hole.

Inside Handle Width

Make sure you have enough clearance to fit your hand and glove (if worn) inside the handle.

- Inside hand clearance should be slightly larger than hand width.
- Ergo-D handles that are too wide may cause you to grip with extra force to prevent the hand from slipping and sliding.
Handle Offset

- If you want to insert the shovel blade parallel to your body, offset the handle from the blade to keep the wrist in neutral position when centering the hole in front of you.
- If you don’t offset the handle, make the opening at an angle to your body so that the wrist on the shovel hand is maintained in a neutral position.

Handle or Staff Diameter

- The handle should be loose in your grip when you hold the tip of your thumb and middle finger together.
- Make handles 1 cm smaller than your hand’s grip diameter.
- Most people have a grip diameter of 4–5 cm. Handle diameters are approximately 3.5 cm, and thus are appropriate for the average hand size. If you have a large or small hand, the handle may not fit properly in your hand and you will increase your grip force.

- If the handle or staff diameter is too small, build up the diameter by wrapping the handle with material e.g. neoprene or bicycle handle wrap.
- If the handle is too big in your hand, rebuild it by peeling the existing handle off and covering the core to appropriate thickness.
The grip on this type of handle reduces shock impact to the hand and arm.

Use a staff handle:
- when planting in hard or rocky ground
- when experiencing symptoms of tendonitis (see “Signs and Symptoms of MSI”) in your shovel arm

**Caution:** When using the staff handle, avoid bending the thumb-side of the wrist toward the forearm — an awkward wrist posture called radial deviation. This awkward posture may occur when aiming a shorter shovel too far forward to penetrate the soil.

This can be avoided by using a staff handle of appropriate length and penetrating the soil closer to the body.

Avoid twisting the blade using your wrist. This awkward wrist posture may occur when opening or closing the hole. Keep wrist neutral and move elbow towards your body instead.
Avoid raising the hand above head height when penetrating the soil.

Staff handle lengths should be no longer than shoulder height of the planter!

**Blades**

**Length and Width**

The key is to have a blade large enough to make an adequate hole size.

- Avoid inserting the seedling with any force using the seedling hand. To avoid excessive force, make sure the hole is deep enough for the seedling plug to fit properly and wide enough to fit your hand.

- Blades should be as long as the longest plug to be planted, or a minimum of 15 cm, to ensure the hole is deep enough to allow the seedling plug to be fully inserted. Blades shorter than the plug means you can’t push the shovel into the ground with your foot and still dig an adequate hole.

- Blades with a slightly pointed and tapered shape not only make it easier to penetrate the ground, but also form a definitive bottom in the hole into which the plug should fit.

- To allow the blade to be pushed in by the foot in harder ground, a kicker should be located on the correct side—typically on the right side for a right-handed planter facing the concave side of the shovel.

- Blades should be as wide as your hand at the knuckles. If you wear a glove on the seedling hand, consider the extra clearance needed to fit your hand and glove into the hole.

- Note that blades wear down several centimeters per season.
Shock and Vibration

In tree planting, repeated shocks to the hand and arm are a major concern for chronic injury.

• Unexpectedly high forces can be generated at the hand when the planting tool strikes hidden roots or rocks.

• If the handle is made from a hard material (left), use a layer of softer vibration absorbent material between the handle and hand to cushion impacts (right).

Vibration absorbent material, available in gloves or as handle wraps, can reduce risk of injury and improve performance in several ways:

• Reduces contact stress by deforming to the shape of the hand. This spreads the load and lowers tissue stress for the same force.

• Absorbs the higher frequencies of vibration that accompany impacts.

• Reduces lateral and fore-aft vibrations transmitted to the hand.

• Provides greater comfort.

Impact and vibration absorbing materials are sold under trade names such as: Viscolas, Visco Elastic Polymer, Sorbothane.

Suppliers for handle wrap and gloves:
National Ergonomic Supply Inc. (B.C.), Ergotech Protective Devices Inc. (Ont.), or your tree planting equipment supplier.
Benefits of vibration absorbent wraps and gloves

- A material with good deformation characteristics will feel more comfortable — no concentrated areas of high tissue pressure.
- When built into a glove, vibration absorbent material also protects the hand from cold, improving blood flow, tactile sensitivity and dexterity.
- If the glove is too bulky, it will reduce dexterity and tactile sensitivity. Therefore, optimum glove thickness is important and depends on the task complexity.

Use a glove designed for the job

- Vibration absorbent material should cover the palm and the first joints of the fingers.
- Half-finger gloves allow greater finger sensitivity and dexterity.
- In hot weather, use a handle-wrap with a thin glove.
- In cold weather, a vibration absorbent glove will also provide thermal protection.
Bags

Padding Material, Width and Thickness

Things to look for when purchasing a set of bags:

- **Padding** – Obtain replaceable padding, since padding that wears thin puts more stress on the body.
- **Clasps** – Keep spare clasps since they tend to break.
- **Sizing** – If using the harness, make sure the belts adjust enough to fit your waist and shoulders.

Experienced planters replace the original padded waistbelt with a replacement backpack waistband sold by larger outdoor stores. They also replace the waistbelt clasp with an unbreakable seat belt buckle.

Considering the amount of time a planter has to wear the bags, the weight of the bags and the work/terrain conditions, it makes good ergonomic and economic sense to make carrying them as comfortable as possible!

Bag Loading

The muscles surrounding the spine work less when the spine is evenly loaded.

- Keep seedling weight balanced on the left and right sides of your body.
- Shift seedlings as planting progresses to avoid uneven loading.
Bag Weight

Recommended maximum sustained back pack weight is 15% of your body weight.

That means that if you weigh 77 kg (170 lbs), you should not carry more than 12 kg (26 lbs) on your back on a continuous basis. If some of the load is carried on the hips and planting steadily decreases this load, the maximum bag weight should be no more than 18 kg (40 lbs).

**Caution:** Bag weights that greatly exceed the guideline will accelerate spinal fatigue and increase risk of back pain.

- Use secondary caches on long runs and bag up more frequently to reduce bag weights.

Support Location

- Fasten the waist belt above your hips to support most of the weight on the hips when standing upright.
- If used, shoulder straps help to balance and stabilize the load, and to take some of the load off the hips, e.g., 20% on the shoulders and 80% on the hips.
- If too much of the load is carried by the shoulder straps, they may impede upper-body freedom of movement and put extra weight on the spine. Adjust them accordingly.

Warm-Up Exercises

These are warm up exercises that can be performed prior to physical activity especially first thing in a work-shift and after a break when the body has cooled down. Avoid exercising immediately upon rising from bed without first warming up the entire body. For example, spend 5-10 minutes getting ready for the workday. This decreases spine stiffness and prepares the body for specific stretching exercises, such as those described on the following pages.

**Do not over-stretch.** The purpose of these exercises is to move through a normal range of motions, lubricate the joints, and encourage muscle balance. It is not the right time to try and gain flexibility by doing a deep stretch.

**Perform the movements slowly and purposely.** Focus on keeping the body aligned. Never bounce.

**Never push yourself through any exercise if it feels uncomfortable.** The warm-up exercises presented here should not be difficult to perform. However everybody is different. Modify the exercise to suit your fitness and health level. Back off the stretch and correct your body alignment if you feel pain or discomfort.
1. The Bicycle - to warm up the lower body

A. Lift right leg out in front of body.
   • Lead with the knee.

B. Straighten Right leg out.
   • You should feel a muscle stretch down the back of the thigh (hamstrings).

C. Swing right leg back until the toes of the right foot reach the heel of the left foot.
   • You should feel a muscle stretch in the front of the hips (Hip flexors).
   • Transfer weight to right leg.
   • Repeat cycle with left leg.
   • Repeat 15 times

• Do not step too far back

Note you will travel backwards with each cycle for each leg. (Watch out behind you!)
2. Inner/Outer Thigh Stretch - to warm up the inner and outer leg muscles

**Inner Thigh**
- Stand with legs wider than shoulder width apart.
- Lean to one side then the other.
- You should feel a stretch on the inner thigh.
- Hold for a count of 3 each side.
- Repeat 10 times.

**Outer Thigh**
- Cross right leg in front of left and push hip right.
- You should feel a stretch on the outer right thigh.
- Repeat with other leg.
- Hold for a count of 5 each side.

Do not let knee go past the foot

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3. Calf Stretch - to warm up the lower leg muscles and tendons

- Stand facing a tree or another object to lean against.
- Place one foot behind the other.
- Keep both feet facing forward.
- Lean forward towards the wall with the body in a straight line. Bend the forward knee slightly while keeping the rear leg straight.
- Press the heels to the floor.
- You should feel a stretch in the calf and ankle of the back foot.
- Do not bounce.
- Hold for a count of 5 each side.

Do not turn the back foot out
4. Hamstring Stretch - to warm up the back of the thighs

- Place the left heel out in front of the body.
- Use a sturdy object 30 - 45cm high if available.
- Support some weight onto the right leg if you want to.

Hold for a count of 5 each side.

Keep lower back flat, not rounded

- Slowly bring the hands down and away from the body.
- You should feel a stretch down the back of the thigh.
- Hold for a count of 5 each side.

5. Quad Stretch - to warm up the front of the thighs and hips

- Hold onto a wall or other sturdy surface.
- Grab the bottom of your right pant leg.
- Grab your ankle if you are more flexible.
- Push the hips forward.
- You should feel a stretch along the front of the hips and thigh.
- Hold for a count of 5 each side.

Do not arch the lower back
6. Arm Swings - to warm up the upper body

• Stand with your feet shoulder width apart.
• Swing arms vigorously backward and forward.
• Accelerate the arms on the backwards swing.
• Keep the shoulders relaxed. Let the shoulders raise and lower as the arms swing.
• Repeat 40 - 50 times.

Do not twist

7. Shoulder Rolls - to warm up the shoulders

• Shrug shoulders then roll shoulders backwards.
• Repeat 5 times.
8. Arm Circles - to warm up the body and arms

- Circle both arms slowly in front of the body in the sequence shown.
- Keep arms as close to the body as possible.
- Think of stretching through the arms to the fingertips as you make the circle.
- You should feel a stretch through the shoulders and arms.
- Move slowly.
- Repeat 5 times.
- Circle arms slowly 5 times in the opposite direction.

**Do not let shoulder tense**
9. Mid Back Stretch - to warm up the mid back and shoulder blades

- Place one arm across the front of your chest.
- Use the other hand to hold the arm, pressing just above the elbow.
- You should feel a stretch in the back of the shoulder and mid-back area.
- Hold for a count of 5.
- Repeat with other arm.

Keep the shoulder down and relaxed

10. Finger Stretch - to warm up hands

- Open and close hands.
- When opening your hands spread fingers to stretch.
- You should feel a stretch through your hands and fingers.
- Repeat 10 times.
Warm-Up Exercise Program Summary

1. The Bicycle
   To warm up the lower body:
   Bicycle the leg, ending with the foot touching the heel of the standing leg. Repeat, moving backwards, 15 times.

2. Inner/Outer Thigh Stretch
   To warm up the thigh muscles:
   Stand with legs wider than shoulder width. Lean body to one side, making sure knee does not go past foot. Hold for a count of 3 each side. Repeat 10 times. Then cross legs and push hip out to the side to stretch outer thigh. Hold for a count of 5.

3. Calf Stretch
   Keep body in proper alignment. Hold for a count of 5 and switch legs.

4. Hamstring Stretch

5. Quad Stretch

6. Arm Swings
   To warm up upper body:
   Swing arms forward-backward vigorously 40 - 50 times.

7. Shoulder Rolls

8. Slow Arm Circles

9. Mid Back Stretch

10. Finger Stretch
Exercises for Injury Prevention

Introduction
The repetitive motions of planting trees, use some muscles more than others, and can lead to a muscle imbalance with injuries. Some muscles become long and weak while others become overly strong. When this happens, micro-injuries of the soft tissues occur, and if left untreated, accumulate and develop into an injury. Performing exercises to strengthen commonly weak muscles and stretch commonly tight muscles are crucial for injury prevention. This section demonstrates recommended exercises that can prevent muscle imbalances and the resulting pain and injury.

How repetitive strain injuries develop
Repeated movements and sustained postures, as occur when planting trees, may lead to changes in muscle length, strength, and patterns of muscle recruitment and use. They can also create stiffness. When this occurs minor alterations in the precision of movement in the shoulder, back and wrist joints arises. These impairments in movements injure the soft tissues. If allowed to continue macro-trauma such as repetitive strain injury and pain may result.

Exercises for injury prevention
The main purpose of the following exercises is to prevent muscle imbalances from developing. They will also keep joints flexible and enhance proper body mechanics.

The exercises are divided into sections labeled Wrists, Shoulders and Lower Back. Five of the exercises are aimed at stretching. Without stretching, over-used muscles may gradually lose their flexibility and muscle imbalances may develop. One exercise is aimed at conditioning muscles that may become long and weak and correcting common postural faults that may develop.

In addition to injury prevention, these exercises reduce muscle tension and relax the body, enhance body awareness, promote circulation and assist with co-ordination by allowing free and easy movement.

Instruction on worksite exercises
These exercises are intended to be performed often during the planting day, throughout the entire planting season. They can be performed at the campsite prior to beginning work, as part of a warm-up, throughout the work-shift, or at the end of the work-shift. If performing these exercises while planting, aim to do them two-three times over the course of the planting day, such as at every second bag-up.

Perform these exercises only after the muscles have been warmed up – after performing a warm-up, or after planting one bag-full.
Wrist stretch

Purpose: To stretch the wrists and forearms. Helps to balance repetitive gripping.

Instructions
- Press palms flat (on something about 28” high), hands shoulder width apart (#1).
- Spread fingers and thumb apart.
- Lean forward over your hands (#2).
- Try reversing arm position for a deeper stretch (#3).
- Hold for a count of 15.
- Repeat three times.

Caution: Stop if you get tingling or numbness in your hand. Do not lock or hyperextend your elbows when you perform the stretch.
Shoulders

When standing upright with proper shoulder posture, the palms of your hands should face your legs, not face backwards which is a common postural fault. Proper alignment is necessary for optimal shoulder health. A muscle imbalance may occur when repetitively using those muscles that turn the palm down and elbow out. This palm-down and elbow out position occurs when you hold a D-handled shovel or reach into a bag to grasp a seedling. If you do not have proper shoulder posture and you repetitively use the arm to plant trees, you may develop an upper body repetitive strain injury.

Some muscles that need strengthening are lengthened when putting a shovel into the ground or reaching into a bag to grasp a seedling. These are the middle back muscles and some of the rotator cuff muscles. For example, the lower trapezius muscle fibers keep the shoulder blades pinched down and in. This muscle may get long and weak, resulting in a lack of precise movement in the shoulder joint. This may lead to problems in the shoulder and arm including tendonitis. The rotator cuff muscles that turn the arm out – such as the infraspinatus and teres minor — are often under-used because of a common postural fault. They can become long and weak from turning the palm down and elbow out when tree planting.
Shoulder Blade Squeeze

Purpose: To strengthen the muscles that turn the palms up and elbows down (infraspinatus and teres minor) and pinch the shoulder blades down and together (lower trapezius). This helps prevent repetitive strain injury from frequent arm motions.

Instructions
- Lean against a flat surface (e.g., FIST or a tree) with slightly bent knees.
- Place feet 8” from the surface (e.g., the truck or a tree) and keep back as flat as possible.
- Place forearms against the truck, pinching bottom of shoulder blades together.
- Wrists are shoulder height.
- Slide arms up, keeping forearms against truck or in a similar position.
- Hold for a count of 5.
- Repeat three times.

Caution: If you feel numbness in your hands, do not bring your arms back as far. Stop if you have pain in the shoulders or neck. Do not arch back.
Shoulders - continued

The pectoralis major and latissimus dorsi muscles can become overly strong and tight. These muscles provide the power to insert the shovel into the ground. Even if you have great posture alignment, it is a good idea to stretch these muscles before planting and frequently throughout the day so that shoulder motions are done properly.

(Left) Pectoralis major
(Right) Latissimus dorsi

Shoulder/Pec stretch

Purpose: To stretch the chest muscle (pectoralis major). Helps to balance repetitive arm motion used in planting trees.

Instructions
- Stand with feet shoulder width apart.
- Place hand behind a sturdy surface so arm is just below shoulder height.
- Gently step forward, feeling a stretch in the front of the shoulder and chest muscles.
- Keep your shoulder back. Do not twist.
- Hold for a count of 15 each side.
- Repeat three times

Caution: Stop if you get pins or needles in your hand. Do not perform this stretch if your shoulder easily dislocates.
Lower Back

In the lower body, repetitive lower back bending and occasional twisting can allow a muscle imbalance to develop that may lead to chronic lower back pain. When bending, it is important to have sufficient hamstring flexibility so that bending takes place mainly through the hips and not the spine. To reverse the effects of all the forward bending done when planting trees, stand up and extend yourself backwards to help keep the disc nucleus from straining the posterior ligaments.

Reverse Back Stretch

**Purpose:** To prevent back stiffness and back ligament strain.

**Instructions**
- Stand with feet shoulder width apart.
- Look straight ahead.
- Clasp hands behind back, keeping shoulders back.
- Do not let shoulders roll forward.
- Lean backwards without moving hips.
- Work towards being able to gently pull hands away from body while keeping shoulders back.
- Hold for a count of 15.
- Repeat three times.

**Caution:** If it hurts your shoulder when you bring your arms behind your back, put hands on hips instead.
Hamstring stretch

Start position

Purpose: To stretch the muscle in the back of your thigh. Helps you to bend forward through the hips instead of at the waist, which in turn helps to prevent lower back pain.

Instructions
- Place heel up on a sturdy surface.
- Keep hips in line and knee facing straight up.
- Bend forward from the hips, sliding hand down thigh towards knee.
- Hold for a count of 15.
- Repeat three times each leg.

End position

Caution: Do not do if it causes back pain, or tingling/numbness in the buttocks or leg(s).

Additional Information

It is impossible to plant trees without using some awkward postures, as defined in the Glossary, so the aim of this ergonomics guide is to show how to minimize the awkward postures and perform stretches that reverse the effects of those postures. Together with advice on choosing the right equipment, warm-up exercises and injury prevention exercises, this guide will help reduce the risk of musculoskeletal injuries.

Tree planters should also be aware of other important issues that will affect their health at work. Dr. Delia Roberts studied the benefits of pre-season training and the results are presented in a ‘Fit to Plant Video’ and a ‘Training Log’ available for download at http://selkirk.ca/treeplanting/. Here you can also download dietary advice in the form of a ‘Power Eating for Power Planting Manual’ and ‘Top Ten Tips’ on what and when to eat for maximum energy and recovery.
Glossary of Ergonomic Terms

Shoulder postures of interest

- **Shoulder Abduction**
  - (Elbow out to the side of the body)
  - Awkward posture is > 60°

- **Shoulder Flexion**
  - (Arm is in the front of the body)
  - Awkward posture is > 90°

- **Shoulder Extension**
  - (Arm is behind the body)
  - Awkward posture is > 20°

**Seedling Arm When Retrieving Seedling**

- Arm behind the body
- Elbow out to the side of the body

- Neutral posture
  - (hand on hip)

- Mild to moderate awkward posture

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Shovel Arm

Elbow out to the side of the body

Neutral posture

Mild to moderate awkward posture

Moderate to really awkward posture

Arm to the front of the body

Neutral posture

Awkward posture - hand above head
Wrist postures of interest

**Flexed wrist posture**
(Palm bent down)
Awkward posture is >30°

**Neutral wrist posture**
Wrist is straight in line with forearm

**Extended wrist posture**
(Palm bent up)
Awkward posture is >45°

**Top down view of right wrist radial deviation posture:**
(Palm bent towards thumb)
Awkward posture is >30°

**Top down view of right wrist posture**
Neutral position

**Top down view of right wrist ulnar deviation posture:**
(Palm bent towards pinkie)
Awkward posture is >30°
Seedling Wrist

Neutral wrist posture

Awkward wrist posture: flexion

Shovel Wrist

Neutral wrist posture

Awkward wrist posture: extension

Awkward wrist posture: radial deviation
Trunk postures of interest

Neutral | Mild awkward | Moderate awkward | Really awkward

Trunk postures when planting

Neutral | Mild awkward | Moderately awkward | Really awkward

No twist - neutral trunk posture

Twisting results in an awkward trunk posture.
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