bloom. Males start emerging on day 19 and females usually emerge after day 20. Emergence is usually complete by day 29 to 30.

If the weather is inclement, bee emergence may be delayed for 7 to 10 days by lowering the temperature of the incubator to 10-15°C prior to or during emergence. It is important to monitor temperatures in the incubation trays as changes in ambient air temperature do not always alter temperatures in the trays. As an alternative, emerged adult bees can be held at 6°C for 2 days or at temperatures ranging from 11 to 16°C for up to 10 days without any appreciable adverse effect.

Beekeepers who operate within a range of 15 to 20 miles could use the system of incubation originated by the Agriculture Canada Research Station at Melfort (See Appendix 1). The basic principle is building special incubators that are housed in a room at 30°C with a RH of approximately 70 percent with forced air for ventilation. The emerging bees are collected in trays and taken daily to field shelters. This system insures maximum emergence of adults, provides an excellent way to control the introduction of chalcid parasites and predators into the field and insures that cells are not left in the field with the accompanying danger of spread of disease.

[iii] Field Shelters

Ultraviolet resistant polyethylene of 4 to 6 ml thickness or fibreglass shelters are used almost exclusively in the northern seed growing areas of British Columbia, Alberta, Saskatchewan and Manitoba. Temperatures are usually higher inside as compared with that on the outside of these shelters and this is important to activate the bees into flight and

foraging. Furthermore, it is mandatory that the entrance to the shelter face south. The latter permits the face of the hives to be exposed to sunlight for extended periods thereby permitting a more even distribution of bees in all the hives in the shelter.

Shelters are either square, rectangular or triangular (A-frame). They are usually made of appropriately sized panels that are stored flat in the off-season and during the growing season, are put together in the field with double-headed nails. In a majority of cases, shelters are usually small and contain nesting material for 20,000 (in a 4' x 4' shelter) or 40,000 (in a 4 x 8' shelter) bees -- the recommended stocking rate for 1 and 2 acres, respectively. Studies are being conducted in the Peace River region of northern Alberta on the use of larger shelters to facilitate pollination of up to 8 acres from one shelter. Prior to the installation of shelters in the field, 3 m (10 ft) pathways from the edge of the crop to each shelter are mowed to permit vehicle access to the shelter with minimal damage to the crop. Shelters are usually set up in the field in June and are removed after the nesting material is taken indoors sometime in late August or early September. The shelters are relatively light and should be firmly anchored into the ground.

Drift or loss of bees from the vicinity of the shelters could be a problem with small shelters. Bees normally drift to the south or west and to end shelters in a row. They also drift to higher elevations and from open fields to sheltered areas. They have been observed to overfly alfalfa for such crops as alsike clover and birdsfoot trefoil. Drift can be minimised by ensuring that there is enough crop bloom before bees are introduced into the field.

(iv) Nesting material

Commercially produced grooved wood and polystyrene nesting boards are the predominantly used nesting materials. These grooved boards are firmly held together in a 30.5 x 56 cm (12 x 22") plywood box or hive to form nesting tunnels for the bees (in some commercial operations 30.5 x 112 cm hives are used for polystyrene nesting boards). The recommended stocking rate is 20,000 cells per acre and a total of about 9,000 tunnels are usually sufficient for 20,000 emerging cells with a 2:1 male to female ratio - i.e., about 1.4 tunnels for each female bee.

Kiln dried white pine and ponderosa pine are generally used in the manufacture of wood nesting boards. They are available in 2 ft. (~ 61 cm) or 4 ft. (~ 122 cm) lengths, 5 1/4" (~ 13 cm) width and 3/8" (~0.95 cm) thickness. Thirteen tunnels are present across the width of the board each about 1/4" (~ 0.64 cm) in diameter. These 2 ft. or 4 ft. lengths are cut into six or twelve 4" sections, respectively. Thus, these wood tunnels are 4" long and 1/4" in diameter. A wood hive has 1378 tunnels (106 boards x 13 holes) and weighs about 45 lbs. (18 kg). Six hives i.e., 8,268 nesting tunnels are made available for each acre of crop to be pollinated.

Most of the polystyrene boards used are available in one length - 3 3/4" (~9.5 cm). They are 11 3/4" (~ 30 cm) wide and 3/8" (~ 9.5 cm) thick. Thirty tunnels are contained across the width of the board, each 3 3/4" long. Fifteen of these tunnels are 8/32" (0.64 cm) in diameter and the other fifteen are 9/32" (~ 0.71 cm) in diameter. A 30.5 x 56 cm polystyrene hive has 1500 tunnels (50 boards x 30 holes) and weighs about

15 lbs. (7 kg). Six hives, i.e., 9,000 nesting tunnels are made available for each acre of crop to be pollinated.

The face of the nesting boards should be sprayed with a black or dark stain with a linseed oil base. After the dark stain is dry, fine line patterns in a contrasting stain (e.g., blue, beige or green) should be sprayed or painted on about one-third of the area. These patterns (usually letters of the alphabet) assist bees in orientation.

Disposable nesting material made of fluted craft paper with tunnels 3" (~8 cm) long and 7/32" (~0.56 cm) in diameter are now being marketed in the U.S. under the Rol-A-Board trademark. Rol-A-Board is sold as a pollinating unit. Each unit consists of four rolls (each with 1,500 holes) attached to a backing made of cardboard. To date, this nesting material has not been used extensively in northwestern Canada.

(vi) Introduction of bees into alfalfa seed fields

Incubation trays are taken out into the field when about 40 percent of the male bees and about 5 to 10 percent of the female bees have emerged. Ideally, this should coincide with about 10 percent bloom of the crop.

The length of time for completion of emergence is dependent on temperature. Thus, if bees are placed in the field when about 40 percent of the males have emerged and the daytime temperatures are in the 25 to 30°C range, most of the pupae will usually complete development and chew their way out of their cells in 7 to 10 days. However, if temperatures stay below 19°C for up to 5 days, emergence will be considerably delayed. To prevent this from happening, trays should be brought indoors and

reincubated for 1 to 2 days at 30°C. Also if incubation facilities are in close proximity to the field, trays could be brought indoors and incubated overnight on a daily basis. Bee emergence is then completed within a week. However, in most instances this is not practically feasible, and trays are kept in the shelters for up to 3 weeks to facilitate maximum emergence. Extremes in temperature at this stage is detrimental to developing pupa. It has been shown that significant mortality occurs after 9 days continuous exposure to low temperatures between 4 to 5°C. At the other extreme, developing pupae can withstand temperatures up to 45°C for up to one hour with no significant reduction in emergence. However, emergence is significantly reduced if this exposure time at 45°C is increased to 2 or 3 hours. An increase in temperature to 50°C for any length of time results in total mortality. It is therefore advisable to ensure that incubation trays are kept away from such temperature extremes. For example, if air temperatures inside the shelter are above 38°C incubation trays could be placed outside the shelter, preferably in the shade. Air temperatures inside polyethylene and fibreglass shelters are higher than those outside the shelter. Emerging bees are able to cope with extremes of temperature more so than pupae that have not completed development. It should be noted that in literature to date, the effects of extremes of temperature on bee emergence have been recorded but these temperature effects on subsequent bee vigor, life span or reproductive behaviour have not been documented. It is therefore advisable to keep developing pupae away from extremes of temperature whenever practically feasible.

Before trays are taken out to the field, dampen cells in trays to increase humidity. Many unemerged adults die if cells in trays are too dry and tough for the bees to chew their way out. For any distance travelling, a darkened van or truck with provision for ventillation is preferred. If temperatures are too high, ice may be required for cooling. Temperatures between 15 to 20°C during transportation are recommended.

The metal wire screen on top of the tray is usually covered with a layer of coroplast or wax paper to discourage other insects from getting into the tray. Trays are usually left in the shelters for up to 2 weeks to facilitate maximum emergence. During this period, female bees often use old cells in the trays for nesting. After emergence is deemed complete, the cells from each tray should be transferred to a large bag or other container to allow the female bees to fly off before removing the cells from the field. This is best done under warm sunny conditions conducive to flight. Empty cells should be incinerated and disposed of away from field shelters. This is an essential hygiene measure for the prevention of the spread of diseases, parasites and predators of the bee.

In cases where the 'bleed off' system of incubation is used, newly emerged bees are taken out, daily or twice daily as required, in trays to be released into the field. This is done regularly for about two weeks.

(vii) Moving bees during the growing season

Moving bees from one field to another is not recommended. In most instances, pollination is seldom completed in one field to warrant moving bees to another field in the short growing season in northwest Canada. However, if for some reason bees have to be moved, it is best to do so in