However, strong populations of bees can't produce a big honey crop, if there is insufficient availability of nectar producing plants or low nectar yield per plant. One point not made absolutely clear by Dr. Crane is that it is possible to exceed the carrying capacity of an area. Just as rangeland can only support a limited number of cattle per acre, an area's floral resources may limit how many colonies can both be successfully supported and expected produce a maximum honey crop.

Although unlikely to be a problem for a beekeeper with just a few colonies, in areas of intense agriculture or during periods of high bee colony density, such as during pollination of orchards and other crops , there may be too many colonies in one place to make much of a honey crop. In fact, on some crops being pollinated, bees have to be fed to survive. The grower wants sufficient bee density to pollinate every blossom, but these blossoms may not yield enough nectar and pollen to meet the nutritional needs of such a high density of bees.

In terms of honey production, we need to remember that plant species vary widely in terms of both the quantity and quality of nectar produced which affects potential honey yield. For your convenience, I have extracted from Eva's book and added them to this section of the course. One Table ranks over 200 plants in terms of honey production. You'll immediately notice that some plant species offer copious amounts of nectar to bees, and others are stingy. The other Table lists the sugar content of the nectars from a wide variety of plants. Some plant species provide a rich food source to bees, while others provide minimal nutrition. Plants have developed different ways of attracting pollinators. Some offer lots of food, others provide high quality food. But this requires significant energy expenditure by the plant, so most plants don't offer plentiful amounts of high sugar content nectar. It tends to be one or the other, but not both.

Dr. Crane developed a ranking system for comparing various plant species in terms of the potential amount of honey that can be produced. Her classification scheme establishes classes expressed as pounds of honey yield per acre:

Class 1	***Class 2***	***Class 3***	***Class 4***	***Class 5***	***Class 6***
0-25 lbs	26-50 lbs	51-100 lbs	101-200 lbs	201-500 lbs	>500 lbs

Some examples of honey yields from Dr. Crane's extensive Tables:

- Class 1: Honeysuckle, Watermelon, Chestnut, Nettle, Milk-Vetch, Flax, Quince, Pear;

- Class 4: Norway Maple, Borage, Knapweed, Dandelion, Rapeseed, Teasel, Lavender, Catmint, Rosemary, Birdsfoot-Trefoil, Clover, Hollyhock, Cotton, Buckwheat, Willow;
- Class 6: Common Maple, Milkweed, White Dead-Nettle, Sage, Common Thyme, White Sweet Clover. , she ranked the nectar quality from various plant species according to sugar values expressed as milligrams of sugar per flower over 24 hrs. Some examples of plants with nectars of high, moderate, and low sugar concentrations are:
- 5.4 (mg/flower/24 hr) *Tilia platyphyllos* (Linden), 4.38 *Salvia leucantha* (Mexican Bush Sage), 4.11 *Ribes uva-crispa* (Gooseberry), 3.80 *Rubus idaeus* (Raspberry);
- 1.5 *Prunus avium* (Cherry), 1.37 *Malus sylvestris* (Crab Apple); 0.07 *Centaurea hyalolepis* (Composite), 0.06 *Lamium amplexicaule* (Herb), 0.05 *Sinapis arvensis* (Wild Mustard), 0.2 *Thymus serpyllum* (Creeping Thyme), <0.004 *Melilotus officinalis* (Yellow Sweet Clover, 0.2 *Trifolium repens* (White Clover).

To be more specific, in Montana in the spring, if we've had good snowfall in the winter, followed by an early summer with very warm days, and our colonies are in good shape, we can get a situation where much of the state turns yellow with an extensive bloom of yellow sweet clover. During those years, the sweet clover covers hills and valleys for miles and miles. Honey bee colonies can make honey at a startling rate. But, we tend to only realize this potential bloom every 2-3 years, and only if all of the weather conditions are right.

I remember years ago, the wife of a large scale beekeeper in eastern Montana commenting on the fragrance of the sweet clover and its extent that spring, saying: "I think I could wring the nectar out of the sweet clover, there's so much of it". However, note that sweet clover has a very low sugar content. It's a great honey crop for the beekeeper, but not the best nectar for feed for the brood.

Which brings us to the other part of the nutritional equation, the pollen. Pollen is a critical food source for colony growth. One way of ranking the quality of pollens is by plevel. Dr. Somerville's book provides information about the protein content of various pollens. Most bee specialists agree with the following ranking based on crude protein:

- 25% or greater, quality
- Less than 20%, quality

Thus, a colony would need to collect 3 kg (6.6 lb) of pollen at 20% crude protein to equal the protein in just 2 kg (4.4 lb) of pollen at 30%. A colony consumes 25–55 kg (55-121 lb.) of pollen per year. The time and energy expended in collecting 55 kg or 121lb of low protein content pollen would clearly be more than that needed if they collected 25 kg or 55 lb. of higher quality pollen. Don't forget, colonies have field forces of foragers that collect nectar and honeydew, pollen, propolis, and water; and these foragers tend to specialize in which resource they are focused on gathering. Every additional bee needed to collect pollen is one less bee available to collect honey or other resource.

AUSTRALIA: TASMANIA

Beekeeping in Tasmania. T. D. Raphael & D. G. Cunningham (Hobart, 1954) [270/55

AUSTRALIA: VICTORIA

Honey flora in Victoria. Victoria Dep. Agriculture (5th ed., 1949)

AUSTRALIA: WESTERN AUSTRALIA

Honey plants in Western Australia. F. G. Smith *Bull. Dep. Agric. West. Aust.* No. 3618 (1969) [143/71

Commercial bee-keeping. 2. Honey flora of Western Australia. R. S. Coleman *Bull. Dep. Agric. W. Aust.* No. 3038 (1962)

K Trees of Western Australia, no. 1–109. C. A. Gardner Series in *J. Dep. Agric. W. Aust.* (1952–1966) [293/53, 272/62, 675/66

FIJI

Rural industry: bee keeping. G. B. Gregory *Agric. J. Dep. Agric. Fiji* 31: 42–43 (1961)

HAWAII

Rehabilitation of the beekeeping industry in Hawaii. J. E. Eckert (Hawaii, 1951) [158/53

Fundamentals of beekeeping in Hawaii. J. E. Eckert & H. A. Bess *Ext. Bull. Univ. Hawaii* No. 55 (1952)

A brief survey of Hawaiian beekeeping. E. F. Phillips *Bull. U.S. Bur. Ent.* No. 75: 43–58 (1909)

NEW ZEALAND

Handbook of New Zealand nectar and pollen sources. R. S. Walsh *Upper Hutt, N.Z.* (1967) [731/68

P Pollen in honey and bee loads. W. F. Harris & D. W. Filmer *N.Z.J. Sci. Tech.* A 30: 178–187 (1948)

APPENDIX 1

Table 1.3/1.
Potential honey yields of 200 honey plants

This table gives the estimated 'honey potential' of 200 flowering plants measured as the maximum quantity of honey (in kilograms) that could be obtained in the course of a season from 1 hectare of land (or in pounds obtainable per acre, which is nearly equivalent). Optimal growing conditions are assumed, and an adequate force of foraging bees to collect all the nectar secreted. (*See* Section 1.3, pages 22–24.)

Class 1 = 0–25 kg/ha	Class 4 = 101–200 kg/ha
Class 2 = 26–50	Class 5 = 201–500
Class 3 = 51–100	Class 6 = over 500

Many of the entries are based on sources in the U.S.S.R., especially M. M. Glukhov (1955), N. F. Fedosov (1955), A. M. Kuliev (1952); Poland, especially Z. Demianowicz (1960, 1963); Rumania, especially A. Nyárády (1958).

Plants in Appendix 1 and Appendix 2 are listed in alphabetical order of family, and within each family in alphabetical order of genus. Where possible, authorities for plant names have been obtained from:

Flora Europaea ed. T. G. Tutin *et al.* (Cambridge: University Press) Vol. 1 (1964); Vol. 2 (1968)

Manual of cultivated plants L. H. Bailey (New York: Macmillan) 1949, reprinted 1971

I am indebted to the staff of the Royal Botanic Gardens, Kew, for help with plants not described in any publications accessible to me. Names whose authority could not be established are quoted as in the source publication.

	Class						
Plant species	1	2	3	4	5	6	*Common name*
Aceraceae							
Acer campestre L.	.	.	.	.	.	x	common maple
Acer platanoides L.	.	.	.	x	.	.	Norway maple
Araliaceae							
Hedera helix L.	.	.	.	.	x	.	common ivy
Asclepiadaceae							
Asclepias syriaca L.	.	.	.	.	.	x	common milkweed
Boraginaceae							
Anchusa officinalis L.	.	.	x	.	.	x	bugloss
Borago officinalis L.	.	.	.	x	.	.	borage
Cynoglossum officinale L.	.	.	.	x	.	.	hound's tongue
Echium vulgare L.	.	.	.	.	.	x	viper's bugloss
Symphytum asperum Lepech.	.	.	.	.	x	.	rough comfrey
Symphytum caucasicum	.	.	.	x	.	.	Caucasian comfrey
Caprifoliaceae							
Lonicera caucasica	x	.	.	.	.	.	Caucasian honeysuckle
Lonicera fragrantissima Lind. & Paxt.	x	.	.	.	.	.	yellow jasmine honeysuckle

Plant species	Class 1	2	3	4	5	6	Common name
Lonicera iberica	x	.	.	.	.	.	Iberian honeysuckle
Lonicera xylosteum L.	x	.	.	.	.	.	fly honeysuckle
Sambucus ebulus L.	.	x	.	.	.	.	danewort
Viburnum opulus L.	.	x	.	.	.	.	guelder rose
Compositae							
Arctium lappa L.	.	.	.	.	x	.	great burdock
Aster amellus	.	x	.	.	.	.	Italian star-wort
Aster tripolium L.	.	x	.	.	.	.	sea aster
Carduus hamulosus	.	x	.	.	.	.	hooked thistle
Centaurea cyanus L.	.	.	x	.	.	.	cornflower
Centaurea iberica	.	.	x	.	.	.	Iberian cornflower
Centaurea jacea L.	.	.	.	x	.	.	brown-rayed knapweed
Cichorium intybus L.	.	.	x	.	.	.	chicory
Cirsium ciliatum	.	.	x	.	.	.	hairy thistle
Echinops cummutatus	.	.	.	x	.	.	
Echinops sphaerocephalus L.	.	.	.	.	x	.	globe-thistle
Helianthus annuus L.	.	x	.	.	.	.	common sunflower
Solidago L.	.	.	.	x	.	.	golden rod
Solidago gigantea Aiton	.	.	.	.	x	.	
Taraxacum officinale Weber	.	.	.	x	.	.	dandelion
Cruciferae							
Barbarea vulgaris R. Br.	.	.	x	.	.	.	winter cress; yellow rocket
Brassica napus L. subsp. *oleifera* DC.	.	.	.	x	x	.	rape, coleseed
Brassica oleracea L.	.	.	x	.	.	.	wild cabbage
Eruca vesicaria subsp. *sativa* Miller	x	.	.	.	.	.	salad rocket
Sinapis alba L.	x	.	x	.	.	.	white mustard
Sinapis arvensis L.	.	.	.	x	x	.	charlock
Isatis tinctoria L.	.	.	.	x	.	.	woad
Raphanus raphanistrum L.	.	x	.	.	.	.	wild radish
Cucurbitaceae							
Citrullus vulgaris Schrad.	x	.	.	.	.	.	water melon
Cucumis melo L.	.	x	.	.	.	.	melon
Cucumis sativus L.	.	x	.	.	.	.	cucumber
Cucurbita maxima Duchesne	.	.	x	.	.	.	giant pumpkin
Cucurbita pepo L.	.	x	.	.	.	.	pumpkin/squash/ marrow

Plant species	Class 1	2	3	4	5	6	Common name
Dipsacaceae							
Cephalaria caucasica	.	.	.	.	.	x	
Dipsacus fullonum L. ssp. *sylvestris* Hudson	.	.	.	x	.	.	wild teasel; fuller's teasel
Dipsacus strigosus	.	.	.	x	.	.	
Scabiosa bipinnata	.	.	.	x	.	.	
Scabiosa caucasica Bieb.	.	.	.	.	x	.	Caucasian scabious
Ericaceae							
Calluna vulgaris (L.) Hull	.	.	.	x	.	.	ling heather
Fagaceae							
Castanea sativa Miller	.	x	.	.	.	.	sweet chestnut
Geraniaceae							
Geranium pratense L.	.	.	x	.	.	.	meadow crane's bill
Grossulariaceae							
Ribes rubrum L.	.	.	.	x	.	.	red currant
Ribes uva-crispa L.	.	.	x	.	.	.	gooseberry
Hippocastanaceae							
Aesculus carnea Hayne	.	.	.	x	.	.	red horse chestnut
Hydrangeaceae							
Philadelphus caucasicus	.	.	x	.	.	.	Caucasian syringa
Hydrophyllaceae							
Phacelia tanacetifolia Bentham	.	.	.	.	x	x	phacelia
Labiatae							
Ajuga genevensis L.	.	.	.	.	x	.	erect bugle; gout ivy
Ajuga orientalis	.	.	.	x	.	.	oriental bugle
Ajuga reptans L.	.	.	.	.	x	.	bugle
Ballota nigra L.	.	.	x	.	.	.	black horehound
Ballota ruderalis	.	.	.	x	.	.	
Clinopodium vulgare L.	.	x	.	.	.	.	wild basil
Dracocephalum L.	.	.	.	.	x	.	dragon's head
Dracocephalum moldavicum L.	.	.	.	.	x	.	Moldavian balm
Galeopsis angustifolia Hoffm.	x	.	.	.	.	.	narrow-leaved hemp-nettle

Plant species	Class 1	2	3	4	5	6	Common name
Glechoma hederacea L.	.	.	x	.	.	.	ground ivy
Hyssopus officinalis L.	.	.	.	x	x	.	hyssop
Lamium album L.	.	.	.	x	.	x	white dead-nettle
Lamium maculatum L.	.	.	.	x	.	.	spotted dead-nettle
Lamium purpureum L.	.	x	.	.	.	.	red dead-nettle
Lavandula	.	.	.	x	.	.	lavender
Leonurus cardiaca L.	.	.	.	.	x	.	motherwort
Marrubium vulgare L.	.	x	.	.	x	.	white horehound
Melissa officinalis L.	.	x	.	x	.	.	balm
Mentha longifolia (L.) Hudson	.	.	.	.	x	.	horse-mint
Nepeta cataria L.	.	.	.	x	x	.	catmint
Nepeta grandiflora	.	.	.	x	x	.	
Nepeta mussinii Sprengel	.	.	.	.	x	.	
Nepeta nuda	.	.	.	x	.	.	
Nepeta transcaucasica	.	.	.	.	x	.	
Nepeta zangezura	.	.	.	.	x	.	
Ocimum basilicum L.	.	.	x	.	.	.	sweet basil
Origanum vulgare L.	.	.	.	x	.	.	marjoram
Perilla L.	.	x	.	.	.	.	perilla
Phlomis pungens	.	.	.	x	.	.	
Phlomis tuberosa	.	.	.	x	.	.	
Prunella laciniata (L.)L.	.	.	x	.	.	.	
Prunella vulgaris L.	.	.	.	.	x	.	self-heal
Rosmarinus officinalis L.	.	.	.	x	.	.	rosemary
Salvia nemorosa L.	.	.	.	.	x	.	woodland sage
Salvia officinalis L.	.	.	.	.	x	x	sage
Salvia sclarea L.	.	.	.	x	.	.	clary
Salvia verbenaca L.	.	.	.	x	.	.	English clary; wild sage
Salvia verticillata L.	.	.	.	.	.	x	whorl-flowered clary
Salvia virgata	.	.	.	x	.	.	
Satureia vulgaris	.	.	x	.	.	.	savory
Stachys annua (L.)L.	.	.	.	x	.	.	woundwort
Stachys germanica L.	.	.	.	.	x	.	downy woundwort
Stachys iberica	.	.	x	.	.	.	Iberian hedge-nettle
Stachys olympica Poir.	.	.	.	.	x	.	lamb's ear
Stachys palustris	.	.	.	.	x	.	marsh woundwort
Stachys sylvatica L.	.	.	.	x	.	.	hedge woundwort
Teucrium chamaedrys L.	.	x	.	.	.	.	wall germander
Teucrium orientale	.	.	x	.	.	.	oriental germander
Teucrium polium L.	.	.	.	x	.	.	pennyroyal germander

Plant species	Class 1	2	3	4	5	6	Common name
Thymus kotschyanus	.	.	.	.	x	.	
Thymus pulegioides L.	.	.	.	x	.	.	larger wild thyme
Thymus rariflorus	.	.	.	.	x	.	
Thymus serpyllum L.	.	.	.	x	.	.	wild thyme
Thymus vulgaris L.	.	.	.	.	.	x	common thyme
Ziziphora tenuior	.	x	.	.	.	.	
Leguminosae							
Astragalus alpinus L.	.	x	.	.	.	.	alpine milk-vetch
Astragalus cancellatus	x	.	.	.	.	.	
Astragalus stevenianus	.	.	x	.	.	.	
Caragana arborescens Lam.	.	.	.	.	.	x	pea tree
Cercis siliquastrum L.	.	.	x	.	.	.	Judas tree
Cicer arietinum L.	x	.	.	.	.	.	chick pea
Gleditschia Clayton	.	.	.	.	x	.	honey-locust
Gleditschia triacanthos	.	.	x	.	.	.	honey-locust
Lathyrus digitatus (Bieb.) Fiori	.	.	.	.	x	.	
Lathyrus hirsutus L.	.	x	.	.	.	.	hairy vetchling
Lathyrus miniatus	.	.	.	x	.	.	
Lathyrus pallescens (Bieb.) C. Koch	.	.	.	x	.	.	
Lathyrus sativus L.	.	x	.	.	.	.	chickling-vetch
Lotus corniculatus L.	.	x	.	x	.	.	birdsfoot-trefoil
Medicago sativa L.	.	.	.	.	x	.	lucerne; alfalfa
Melilotus alba Medicus	.	.	.	.	x	x	white melilot
Melilotus officinalis (L.) Pallas	.	.	.	x	.	.	common melilot
Onobrychis arenaria (Kit.) DC	.	.	.	x	.	.	
Onobrychis cyri Grossh.	.	.	.	x	.	.	
Onobrychis radiata (Desf.) Bieb.	.	x	.	.	.	.	
Onobrychis viciifolia Scop.	.	.	x	x	.	.	sainfoin
Robinia pseudoacacia L.	.	.	.	.	.	x	acacia
Sophora japonica L.	.	.	.	x	.	.	sophora
Trifolium campestre Schreber	.	x	.	.	.	.	hop trefoil
Trifolium hybridum L.	.	.	.	x	.	.	alsike clover
Trifolium pratense L.	.	.	.	.	x	.	red clover
Trifolium repens L.	.	.	x	x	.	.	white clover
Trifolium resupinatum L.	.	.	.	x	.	.	Persian clover
Vicia cracca L.	.	.	x	.	.	.	tufted vetch
Vicia faba L.	.	.	x	.	.	.	field bean
Wistaria sinensis (Sims) Sweet	.	x	.	.	.	.	Chinese kidney-bean tree

Plant species	Class 1	2	3	4	5	6	Common name
Liliaceae							
Allium cepa L.	.	.	x	.	.	.	onion
Linaceae							
Linum bienne Miller	x	.	.	.	.	.	pale flax
Lythraceae							
Lythrum salicaria L.	.	.	.	.	x	.	purple loosestrife
Malvaceae							
Althaea officinalis L.	.	.	x	x	.	.	marsh mallow
Althaea rosea (L.)Cav.	.	.	.	x	.	.	hollyhock
Gossypium	.	.	.	x	.	.	cotton
Gossypium hirsutum L.	x	.	.	.	.	.	upland cotton
Hibiscus cannabinus L.	.	x	.	.	.	.	Deccan hemp
Lavatera trimestris L.	.	.	x	.	.	.	
Malva sylvestris L.	.	x	.	.	.	.	common mallow
Onagraceae							
Chamaenerion angustifolium (L.) Scop.	.	.	.	.	x	x	rosebay willowherb
Epilobium hirsutum L.	.	.	x	.	.	.	great hairy willowherb
Pedaliaceae							
Sesamum orientale L.	.	x	.	.	.	.	sesame
Pinaceae							
Picea abies (L.) Karsten	.	.	.	x	x	.	Norway spruce
Plumbaginaceae							
Limonium vulgare Miller	.	x	.	.	.	.	sea lavender
Statice gmelini	.	x	.	.	.	.	
Polemoniaceae							
Polemonium caeruleum L.	.	.	x	x	.	.	Jacob's ladder
Polygonaceae							
Fagopyrum esculentum Moench.	.	.	x	.	x	.	buckwheat
Polygonum baldschuanicum Regel	.	.	.	x	.	.	
Rhamnaceae							
Frangula alnus Miller	.	.	x	.	.	.	alder buckthorn

Plant species	Class 1	2	3	4	5	6	Common name
Rosaceae							
Crataegus L.	.	x	.	.	.	.	hawthorn
Crataegus kyrtostyla Fingerh.	.	x	.	.	.	.	
Cydonia oblonga Miller	x	.	.	.	.	.	quince
Malus orientalis	x	.	.	.	.	.	
Malus sylvestris Miller	.	x	.	.	.	.	crab apple
Prunus dulcis (Miller) D. A. Webb = *Prunus amygdulus* Batsch	x	.	.	.	.	.	almond
Prunus armeniaca L.	.	x	.	.	.	.	apricot
Prunus avium L.	.	x	.	.	.	.	wild cherry
Prunus cerasifera Ehrh.	.	x	.	.	.	.	cherry-plum
Prunus cerasus L.	.	x	.	.	.	.	sour cherry
Prunus domestica L.	.	x	.	.	.	.	plum
Prunus spinosa L.	x	.	.	.	.	.	blackthorn
Pyrus caucasica Fedorov	x	.	.	.	.	.	Caucasian pear
Pyrus communis L.	x	.	.	.	.	.	pear
Rubus caesius L.	x	.	.	.	.	.	dewberry
Rubus idaeus L.	.	.	x	.	.	.	raspberry
Rubus sanguineus Friv.	.	.	x	.	.	.	
Sorbus aucuparia L.	.	x	.	.	.	.	rowan; mountain ash
Sorbus graeca (Spach) Kotschy	.	x	.	.	.	.	
Rutaceae							
Ruta graveolens L.	.	.	.	.	x	.	rue
Salicaceae							
Salix L.	.	.	.	x	.	.	willow
Saxifragaceae							
Deutzia scabra Thunb.	x	.	.	.	.	.	
Scrophulariaceae							
Digitalis purpurea L.	.	.	.	.	x	.	foxglove
Scrophularia nodosa L.	.	.	.	.	.	x	figwort
Solanaceae							
Nicotiana rustica L.	.	x	.	.	.	.	tobacco
Nicotiana tabacum L.	.	x	.	.	.	.	tobacco
Tiliaceae							
Tilia caucasica Rupr.	.	.	.	.	.	x	
Tilia cordata Miller	.	.	.	x	.	x	small-leaved lime

Plant species	*Class* 1	2	3	4	5	6	*Common name*
Umbelliferae							
Coriandrum sativum L.	.	.	.	.	x	.	coriander
Eryngium campestre L.	.	.	.	x	.	.	field eryngo
Heracleum sphondylium L.	.	.	.	x	.	.	hogweed
Verbenaceae							
Vitex negundo incisa Clarke	.	.	.	.	.	x	
Vitaceae							
Parthenocissus tricuspidata (Siebold & Zucc.) Planchon = *Ampelopsis veitchii* Lynch	.	.	.	.	x	.	

APPENDIX 2

Table 1.4/1.
Descriptions of honey, and world distribution, for 150 important plant genera and species

Plants known to be major sources of the world's honey are arranged in alphabetical order of plant family (*see* note to Appendix 1, pages 47–48); *see also* Section 1.4, pages 24–25.

The details given are in two parts:

(1) Botanical name [common name]; type of plant, world distribution and importance. WHCR refers to entries in World Honey Crop Reports (*Bee World*, 1966–1974). HP 1 to HP 6 indicates the 'honey potential' class as set out in Table 1.3/1, pages 47–55.

(2) Characteristics of the honey (in liquid form): colour, density, viscosity (body), flavour and aroma, natural granulation, and any special features.

Acanthaceae

Dyschoriste Nees spp.—annuals/perennials in tropical African wooded grassland
honey very light; fine flavour

Hypoestes Soland spp.—shrubs native to tropical and southern Africa and Madagascar, in wooded grassland
honey very light, fine flavour

Aceraceae

Acer L. spp. [maple, etc.] in Europe, especially *A. pseudoplatanus* L. [sycamore]—trees common in most cool temperate regions of the