THE INFLUENCE OF WEEDS ON AGRICULTURAL COMMODITY PROCESSING AND MARKETING

J.T. Snelson
Department of Primary Industry,
Canberra, A.C.T.

INTRODUCTION

The aim of this section is to bring out the effects and importance of particular weed species on advancing technology in production and harvesting, on product processing, market acceptability, sale value and international trade.

It is remarkable and more than a little disturbing to find that a matter with such wide ramifications for the economy and stability of agricultural enterprises should have received so little attention by weed scientists, administrators, economists and marketing organizations.

When asked to review this subject and act as Discussion Leader for Section 6, I was staggered to find that while many people paid lip-service to the general impression that weeds, weed seeds, plant parts and contaminants derived from weeds are a serious handicap to many primary industries including those of major national importance, all of the leading authorities whom I consulted quite frankly pointed out just how little we know about the subject.

I have gathered together some facts, some opinion and much conjecture, which I bring before you in the hope that the discussion which will be stimulated, will bring to light a real concern for the socio-economic aspects of weeds which are rarely publicized, seldom discussed and almost never researched. If I can stimulate you to share and express my concern for these insidious losses caused by weeds, it is highly likely that the deficiency in our knowledge can be made good. I would like you to consider the situation commodity by commodity.

DAIRY PRODUCE

Plants which give rise to unusual and objectionable flavours in milk and dairy produce are a widespread problem which has plagued the dairy industry in many countries for many generations.

Butter, because of its bland and delicate flavour, is most sensitive, though fresh milk and cream may also be affected. Cheese, having a much stronger flavour, is not affected to quite the same extent as butter but nonetheless suffers serious down-grading when the cows are allowed to graze certain types of pastures or are fed fodders containing aromatic plants.

Hexam scent (*Melilotus indica*), a wide range of cruciferous weeds and some umbelliferous weeds, when eaten by dairy cows, produce taint in milk which can result in rejection or down-grading. Cape weed, watercress and buttercup have been the source of much trouble in Victoria and New Zealand. Bitter cress (*Coronopus didymus*) caused a serious problem, especially in areas of southern Queensland. The ingestion of bitter cress by cows caused a biting taste and sharp odour in milk and a burnt flavour in butter. Unlike many fodder or weed taints, the *Coronopus* taint cannot be removed from milk during pasteurization or from cream for butter making by the normal vacuum steam pasteurization method. The *Coronopus* taint is usually accentuated by heat treatment. It can be released by ultra high temperature (UHT) treatment, but is not removed by subsequent vacuum treatment because of its very low volatility. It therefore persists in the serum fraction of butter, for example. However, if butteroil is subjected to UHT treatment and then is washed with water by contra-flow in a dish stack separator (which removes all of the aqueous phase) the resultant butteroil is taint free. Thus, *Coronopus* taint is removable from butteroil - but not from milk, cream, butter or cheese.

Cape weed is capable of causing serious problems in the dairy industry but fortunately it occurs only on a seasonal basis. Often its flavour in milk is associated with the richness of spring milk but mostly it is removed by normal heating and deodorizing.

Other weeds which regularly cause trouble are landcress, watercress, penny royal, rape, hoary cress, mustard weed and sometimes supplementary feeds such as turnips, swedes, choumoellier and silage if not well made.

Methods devised by the industry to remove objectionable flavours and odours from cream are numerous and diverse. Some include:

- Volatilization of the off-flavour by heat and vacuum.
- Removal of non-fat constituents by re-separation and washing of the cream.

- Treatment of cream with chemicals.
- Complex vacuum deodorization equipment has been designed especially for removing some weed taints and milk evaporators are reported to be effective against some classes of taint.

The Department of Primary Industry, through the inspection service's grading operations and under the Exports (Dairy Produce) Regulations, is concerned with flavour defects which appear in dairy produce. Weed flavours are more likely to be detected in butter than in other types of dairy produce submitted for export. Affected consignments are usually downgraded, causing financial losses to factories and producers. However, during the last decade, the effects of improved extension services by State Departments to dairy farmers and advanced technology in factories has resulted in a dramatic decrease in the amount of second grade butter manufactured and submitted. Table 1 shows the percent of butter submitted for inspection which has been classified as second grade over the 10-year period ending 1973/74. (Figures supplied by the Commonwealth Bureau of Statistics.)

Under State dairy regulations all milk and cream received at a factory is examined by a qualified grader, who determines by sight and smell whether milk or cream is fit for use or manufacture. Dairy Exports Standards Officers carry out organoleptic grading on products submitted for export. Payment for milk and cream is made according to grade results. Price differentials have been partly responsible for improved quality standards.

Improved pasture maintenance and the use of herbicidal sprays have in many instances reduced the impact of weed taint on milk and dairy produce quality. Better feeding practices and improvements in the handling and aeration of milk have contributed greatly to the reduction of loss. However it appears that the introduction of improved pasteurization techniques and the use of sophisticated equipment have had the greatest impact. It has been proven that by subjecting cream to rapid ultra high temperature treatment and instantaneous expansion cooling, it is possible to manufacture taint-free butter from weed-tainted cream without adversely affecting body, texture, grade or storability of butter.

However, all this costs real money to an industry which is already in dire economic straits. Anything which can serve to eliminate offending weeds from dairy pasture and fodder would greatly assist the industry.

TABLE 1

Percent of butter submitted for export classified as second grade

Year	Second grade butter submitted for export percentage
1963/64	7.4
1964/65	5.7
1965/66	5.7
1966/67	5.2
1967/68	4.7
1968/69	3.9
1969/70	3.0
1970/71	3.1
1971/72	2.3
1972/73	1.4
1973/74	0.8

GRAIN

The presence of weed seeds or other parts of weed plants in harvested grain can be of great importance from a number of processing and marketing viewpoints:-

1. The phytosanitary requirements specified by some countries which import grain must be satisfied. In some cases, the list of objects of quarantine includes plant (weed) species. The list specified by the USSR is particularly extensive. Almost all countries have such a list and the objects of quarantine vary greatly from one country to another. Some grain buyers specify freedom from particular weed seeds as a contractual requirement when negotiating purchases.
2. Toxicity of the seeds of some weed species is a matter of concern. For example, the seeds of *Datura* spp. and *Argemone ochroleuca* contain toxins and their presence in grain can therefore render that commodity unacceptable for marketing.

3. Specking and general discolouration of wheat flour may result from the presence of excessive quantities of certain weed seeds in a wheat grist. For example, variegated thistle, black bindweed (*Polygonum convolvulus*) and mexican poppy (*Argemone* spp.) seeds can cause this effect.

4. The presence of pieces of oilseeds, for example, broken sunflower seeds, in milling wheat is undesirable because of the difficulty of separation prior to processing and, therefore, the possible risk of oil contamination of milling machinery, especially the blocking of screens.

5. Taint is imparted to milled products manufactured from grain which is excessively contaminated with seeds and/or parts of certain plants. For example, *Melilotus indica, Salvia reflexa* and *Eucalyptus* spp. are notorious in this regard.

6. The presence of undue quantities of weed seeds and other parts of weed plants adds to the so called 'unmillable material' content of grain and depreciates its market value.

7. Weed seed may be unacceptable in grain which is used for planting purposes. The introduction of a declared noxious weed onto a property in seed can lead to legal action against the seller.

8. There is a requirement to comply with tolerances for the presence of weed seeds in stock foods as specified under the provisions of certain legislation, for example, the Stock Foods and Medicines Act, New South Wales. These regulations list 55 seeds or seed capsules of weeds as being completely prohibited from occurring in any stock food consisting wholly or in part of any grain or any seed irrespective of whether such grain or seed is whole or crushed. In addition, there are 30 weed seeds for which a limit of 50 seeds and seed capsules per lb is specified as a maximum permitted in any stock food based on grain.

9. Ergot derived from rye grass is quite a serious problem in parts of Australia because, when it is harvested along with wheat, it is of a size and density which renders it impossible to remove during harvesting and cleaning operations. The toxic nature of ergot renders its presence objectionable and Australian authorities have imposed a limit of 50 mg/kg (equivalent to approximately 30 pieces per litre) as a means of meeting phytosanitary requirements. Although ergot is not exactly a weed, it is derived from a widely distributed weed.

All Australian States have relatively uniform regulations which prescribe standards of physical purity for seed offered for sale. Any line of seed which is found not to comply with the prescribed standards can be withheld from sale until made to comply. If compliance is not obtained within a reasonable time, the seed is destroyed.

Weed contamination of seed falls into three categories;

(a) Seed contamination with a gazetted prohibited weed is ineligible for sale irrespective of the level of contamination. There are over 60 species which fall into this category.

(b) For species other than those prohibited, the regulations prescribe maximum weed seed contents in most commercial crop seeds. These regulations permit contamination levels varying from 0.1 to 1%.

(c) Contamination by parts of weed plants other than the seeds is limited in the regulations by prescribed maximum levels for inert matter. These levels vary from 0.7 to 60%.

In view of the various levels of commercial significance of contamination of wheat by seeds and other parts of weed plants, it is necessary to apply an appropriate range of dockages. This approach has been adopted by the Australian Wheat Board primarily with an eye to the marketing and processing situation. However, it is also hoped that the dockage system encourages growers to take steps to control significant weed species. The tolerance for toxic weed seeds is nil; the tolerance for seeds of thistles, oilseeds and emex is limited to one per half litre in total; the tolerance for other foreign seeds including grass seeds is up to 30 per half litre in total. Wheat violating these tolerances is unacceptable until cleaned or is subject to dockage ranging up to $30 per ton.

SKINS AND PELTS

Weed seeds cause direct loss of value to skins and pelts which has been variously estimated to be as high as 25% of the gross value of the produce.

This loss would be bad enough on its own, but an equally serious position is being reached where the traditional users of our skins and pelts are turning to the use of man-made coverings because of the difficulty of securing enough undamaged

skins for their processes. George estimated that barley grass seed causes damage to New Zealand sheep skins and lamb pelts of more than 10%. Barley grass seed has the ability not only to badly pit skins and pelts but very often to penetrate right through the skin and into the subcutaneous tissue underneath.

Hartley reported that the incidence and severity of pelt damage varied greatly in the different areas investigated. In one area where the incidence was relatively low, 68% of the animals examined had an average of five punctures per pelt. In other districts all the lambs were affected, averaging over 200 holes per pelt.

Loughnan reported that the incidence of damage to lamb pelts in one area of New Zealand rose from 0.08% in 1953 through 0.12% in 1958, 8.7% in 1961 to 22% in 1962. The author reported a staggering increase in the following year and there is every reason to believe that the problem has continued to get worse. In addition to barley grass, storksbill (*Erodium* spp.) are known to damage sheep skins in New Zealand. In Australia, in addition to barley grass, corkscrew grass, spear grass, Mitchell grass and many other native grasses are even more virulent than those afflicting New Zealand sheep. I was unable to find any information on losses to the skin and pelt industry in Australia attributed to weed seed.

MEAT

Although beef may become contaminated and downgraded by the penetration of grass seeds through the cattle hide, by far the worst damage is caused to sheep meat by such seeds as barley grass, spear grass, corkscrew grass and storksbill. These seeds may penetrate the skin and lie beneath the fell. Some however, penetrate the muscle and may continue into the abdomen and thorax. Each seed which penetrates causes a bruise. Some may suppurate and some form abscesses. The mere presence of the weed seeds gives cause for rejecting or downgrading the meat, the presence of infection and bruising is grounds for complete rejection.

Loughnan, reporting the situation in New Zealand in 1965, referred to a line of 176 lambs of which 48 were rejected as seedy and a further 5 as slightly damaged by seeds. Although parts of the rejected carcasses could be salvaged and were sold for local consumption, the value of the affected carcasses was less than half of those classed as 'prime quality'. The author

states "these lambs had been grazed on a paddock of excellent rape. In one little corner where the plough could not reach was a patch of barley grass. It must have been much favoured as a camping place, since every fleece, every pelt and a third of the carcasses had been damaged by the seed".

Following research conducted in New Zealand into the effect of white clover on the flavour of sheep meat, the CSIRO Division of Food Research, Brisbane, has characterized the influence of a number of plants on the flavour of mutton and beef. They found that lucerne, white clover, sweet glycine and dolichos, when eaten by sheep, produce a sharp flavour/odour that is probably undesirable when of strong intensity. Rape produces a sickly odour and flavour, more intense under certain conditions, which most consumers are likely to consider undesirable.

Not all these effects are constant. Some taints, lucerne for example, increase as the time spent grazing them increases. Some pass quickly when sheep are removed from the fodder. Rape produces a much stronger taint after winter grazing than after summer grazing.

Horehound and 'onion weed' are reported to cause severe taint in both sheep meat and beef. When the presence of such taint can be detected by odour the carcass is rejected often without any attempt being made to trace the cause or to take steps to prevent a re-occurrence.

WOOL

The importance of weed seeds and plant parts on the acceptability, market value and processing of wool has been accepted as a fact of life in the woollen trade for many generations and most of the processes and machinery used in converting raw wool into finished textile have been designed to remove the vegetable fault or to ameliorate its presence. However, I find little concrete evidence of the true economic impact of weed contamination and vegetable fault on our wool market and wool industry.

However the effect of such contamination on the competitive position of wool vis-a-vis the threat of synthetic fibres cannot be overstressed. Man-made fibres, which come direct from the factory in a condition ready for conversion into finished textile without the merest trace of vegetable contamination, obviously offer the textile industry a saving in time, money and frustration which represents a considerable financial advantage to the synthetic fibre.

Grazing sheep brush over plants and some parts of these plants adhere to the wool. These plant parts include leaves, twigs or, more frequently, the fruits. Leaves which are spiny, hairy or rolled readily adhere to the wool, but often even the smooth ones become entangled. Twigs are broken off shrubs or trees. Smooth twigs often stay enmeshed but more frequently those which remain have prickles or spines such as those of the galvanized burr.

The greater part of the 'burr' found in wool, however, is made up of the fruits of the plants. Naked seed is seldom found in wool, the seed being enclosed in protective structures. These vary from thin scaly structures, as in grass seeds, to hard, often prickly structures as in the Noogoora burr.

'Burrs' assume varying degrees of importance, according to the angle from which they are viewed. In the manufacture of wool tops for the worsted process, the 'shive' type of burr offers the greatest menace as these plant parts, lying parallel with the wool fibres, slip through the carding and combing machines and remain as blemishes in the manufactured product. Noogoora burr is a pest to the carder because the wool is usually wound very tightly around it, the whole being large and hard. During the carding process, it catches in the teeth of the machine, either blocking or breaking them, because of its size and toughness. Bathurst burrs cause no inconvenience in the carding or combing process because the spines fall off easily, allowing the burrs to fall away freely from the wool. Trefoil burrs or medics, however, unroll so readily that in the 'monkey's eyebrow' state they slip through the carding machines with the wools.

It is difficult to classify the various 'burrs' and vegetable faults according to their relative importance but Noogoora burr (*Xanthium chinense*), Bathurst burr (*Xanthium spinosum*), crowsfoot (*Erodium cygnorum*), shive (*Aristida* spp.) corkscrew grass (*Stipa* spp.), barley grass (*Hordeum leporinum*) and medics (*Medicago* spp.), are most important.

There are a number of costs in wool processing directly related to vegetable matter in wool. These cost areas are:

(a) Wastage - wastage occurs when vegetable fault is removed. Wool fibres become entangled with the fault and are removed with it.

(b) Fibre breakage - during carding, vegetable matter tends to increase the amount of fibre breakage.

(c) Removing burrs - this is the cost of any additional processing required to remove burr.

(d) End breakages - small fragments of burr cause end breakages in spinning and give rise to slubs and unwanted irregularities.

(e) Handle and appearance - small amounts of vegetable matter in the fabric spoil the handle of the cloth and its appearance because they dye differently.

(f) Burling - this is the process of removing vegetable matter from the finished fabric.

Webster and Whan (1966), in reviewing the Australian wool sales in 1963/64 and 1964/65, found that nearly 74% of the wool produced in New South Wales was contaminated with vegetable matter. Of the total wool produced in New South Wales, 58% could be processed on carding machinery fitted with special burr rollers and 16% with heavy burr would require carbonizing.

From their study, the authors concluded that the prices paid at auction for wool free of vegetable fault and equivalent types of wool containing varying degrees of vegetable fault have shown that in general fleece types containing a 'B' fault received similar prices to those paid for fault-free wools. A small discount existed for wools containing the 'C' fault. A significant price discount existed for oddment types containing 'B', 'C', and 'D' faults, the discount rising with increasing burr fault.

It is not valid to draw any conclusions about the occurrence and distribution of vegetable matter in wool by areas within States but the following generalities may be offered:

(a) Western Australia - wool is 90% merino and is mainly free from or contains only light, vegetable fault. There is no carbonizing carried out in W.A.

(b) South Australia - offers wool with a wide variety of vegetable fault from free to medium/heavy fault.

(c) Tasmania - 90% crossbred together with some of the finest Australian merino, both notably free from vegetable fault.

(d) Victoria - vegetable matter incidence varies according to areas of production, but on average, Victorian wools are mainly free or with light, vegetable matter.

(e) New South Wales - again varying (Goulburn offers 90% free or light faults, while the Newcastle figure is around 68%); N.S.W. wools have a generally heavier vegetable matter than the southern and western States.

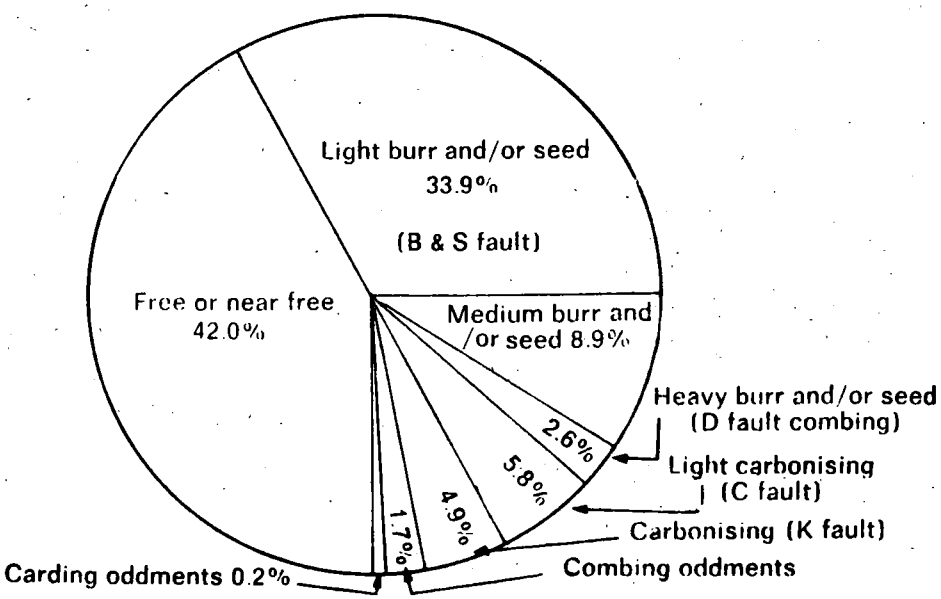
(f) Queensland - on average the State with the highest vegetable matter percentage; over 90% of their clip is merino wool.

Table 2, provided by Mr J.D. Marr of the Australian Wool Corporation, shows the average clean prices achieved in seasons 1974/75 for seven common AWC types of wool. As prices during that season were extremely stable, the comparisons give a reasonable indication of the discounts offered by buyers for wool with varying degrees of vegetable fault. Obviously, the grades of wool which require carbonizing before further processing, and carding oddment types and inferior skirtings suffer the greatest price disadvantage.

Figure 1 shows the distribution of the Australian greasy wool clip according to vegetable fault classification. It should be

FIGURE 1

ANALYSIS OF GREASY WOOL* BY VEGETABLE FAULT



* Refers to wool sold at auction in Australia for season 1972-73.
Source: Australian Wool Corporation.

TABLE 2

1974/75 Average auction prices

AWC Type	Fleece Micron	Price (¢ clean kg)	% Discount
62	21	266	
62B		261	1.9
62C		249	6.4
62S		261	1.9
62L		246	7.5
78	21	256	
78B		255	0.4
78C		245	4.3
78S		254	0.8
78L		228	10.9
79	22	247	
79B		247	-
79C		237	4.0
79S		244	1.2
79L		222	10.1
74	23	235	
74B		235	-
74C		227	3.4
74S		228	3.0
74L		217	7.7
433	25	221	
433B		218	1.4
433C		208	6.3
433S		212	4.1
433L		197	10.9

Table 2 Contd

Skirtings

AWC Type	Micron	Price (¢ clean kg)	% Discount	
163	21	211		No suffix - up to 1% (F.N.F.)
163B		207	1.9	B = 1 - 3% burr
163C		195	7.6	C = 3.1 - 7% burr
163D		177	16.1	D = 7.1 to max combing
163S		199	5.7	V.M. content
163L		181	14.2	S = light seed/shive
				L = heavy " "
494	26	173		K = carbonizing
494B		164	5.2	
494C		147	15.0	
494D		131	24.2	
494S		158	8.7	
494L		148	14.5	

Source - Mr J.D. Marr - Australian Wool Corporation

noted that 25% is composed of wool containing medium burr and/or seed or inferior grades. As the quantity of greasy wool shipped from Australia during 1972/73 was 4 628 442 bales with an average weight of 144 kg, it can be assumed that more than 1 000 000 bales have been sold at prices discounted at between 5 and 25% of their clean value. The loss to the wool industry and to the nation represents such astonishing losses that research, development and extension efforts designed to reduce contamination of wool by vegetable material is not only justified, but is urgently required.

CONCLUSION

I have made no attempt to review or evaluate the effect that weeds have on the design and operation of harvesting equipment. Neither have I referred to the constraints which weeds place on the introduction of mechanical harvesting of fruit and vegetables. The Conference may care to comment in the light of the needs to move towards more highly mechanical methods in the near future.

I hope that delegates will share their experience and concern over these issues as well as those reviewed in this paper in order that we might better assess how weeds influence agricultural technology and the marketing of agricultural produce.