NEW TECHNOLOGY IN SLAUGHTER AND PROCESSING SHEEP

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SUMMARY

An analysis of dressing systems for different species involved in white and red meat production shows that the specific labour input for sheep and lamb traditional slaughter and dressing systems is significantly greater than for other species. Significant development work has been undertaken mainly in New Zealand in the areas of automatic stunning, pelting, hock removal and evisceration. A system incorporating these developments can reduce the manpower required for a traditional system by over 40%.

INTRODUCTION

Over the last 10 years the New Zealand meat industry has invested heavily in developing slaughter and dressing technology for sheep and lambs. This technology aims not only to reduce labour costs but also to improve the quality of the pelt and carcass. The total development programme has been broadly based, with input from many meat industry interests. The programme began in response to increases in labour costs and the implementation of more stringent hygiene regulations, which decreased slaughter and dressing productivity.

The need for labour saving technology in lamb and sheep processing is clearly demonstrated by data in Table 1. The first column gives the number of man hours required to dress 10 000 kg carcass weight for various meat species, starting at stunning and ending at completion of evisceration. These data are then adjusted in the next column to take into account the fact that the dressing operation for mutton, lamb and beef produces two valuable products (the carcass and the skin or pelt), whereas for chicken and pork, the feathers and hair are of little economic value. With traditional dressing systems, even when the man hours are adjusted to take pelt value into account, the labour for dressing sheep and lambs is approximately from two to four times that for other species.

A high average carcass weight gives beef and pork dressing systems their advantage, as many dressing operations (i.e. hock removal, evisceration) are independent of carcass size. On the other hand, chicken dressing has a relatively low labour input, considering the very small carcass size, primarily through adoption of mechanization. Many equipment suppliers have invested large sums of money over many years in the development of chicken processing equipment. This equipment has an extensive world market involving thousands of installations.

This paper describes the major developments in sheep and lamb processing the order they appear in the slaughter and dressing process rather than the chronological order in which they were designed and built.

Table 1. Man hours for producing 10 000 kg dressed carcass weight.

	Hours per 10 000 kg carcass wt	Data adjusted for pelt/hide value: Traditional systems	Data adjusted for pelt/hide value: Fully mechanized sheep chain	Average carcass wt, kg
Chicken	25	25		1.5
Lamb	83	66	32	14
Mutton	60	48	23	20
Pork	15	15		65
Beef	22	18		250

AUTOMATIC STUNNING

Automation of stunning not only reduces costs but also improves workers' safety. All automatic stunners developed to date have used a Vee restrainer system for controlling the location of the sheep throughout the operation. The first automatic stunner for sheep and lambs evolved from a unit developed in Europe for pigs. This unit was then modified for sheep in New Zealand. MIRINZ developed an automatic stunner in which a single Vee restrainer brings the animal to a position adjacent to two grids of electrodes. The grids then move to contact each side of the head. Nozzle electrodes disposed throughout each grid, then administer electrical current to the head, and at the same time emit water, to assist current passage (Fig.1).

This design was improved by Alliance Freezing Company's Ocean Beach plant to cope with horned stock. With the new design, a double Vee restrainer system is used, with one conveyer feeding the other to maintain controlled spacing of animals. The operation of the electrode grids was also altered, which increased the success rate of the machine.

PELTING

Of all the developmental effort involving sheep slaughter and dressing, most has been in the area of pelt removal. In New Zealand alone many different groups, organizations, and engineering companies have developed and refined concepts designed to reduce manpower in the pelting area.

Traditionally, sheep were depelted while hanging from their hind legs. In the late 1970's the benefit of depelting the sheep from the shoulder to the hind leg was recognized, a process most easily done by suspending the animal from the front legs. This process has therefore become known as the "inverted" system. In 1981 MIRINZ developed an inverted manual system that incorporated several existing and new butchery techniques. This system showed considerable manpower reductions over existing systems and has been the basis of virtually all new developments to date. One of its major attributes is its simplicity and ease of installation. It only requires a mechanical puller to remove the pelt from the rear legs (Fig.2). Many variations have been tried in New Zealand and at present at least 10 different designs are being used in meat plants. Most of the designs can process at least eight carcasses per minute.

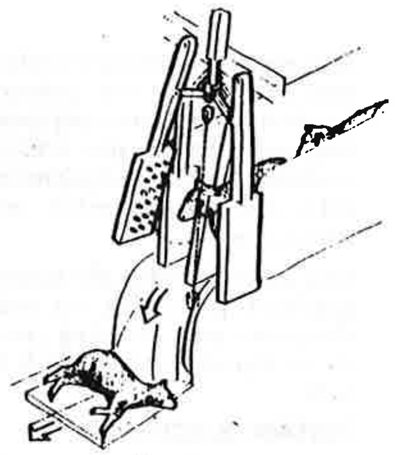

Fig. 1. Automatic stunner for sheep.

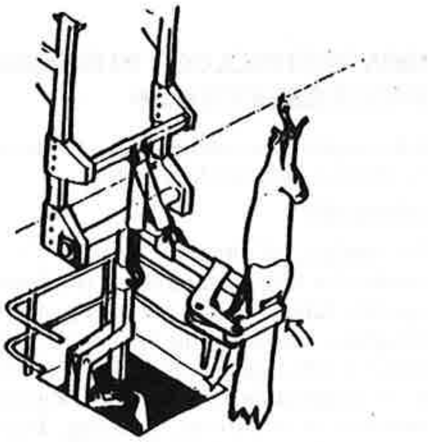

Fig. 2. Final puller.

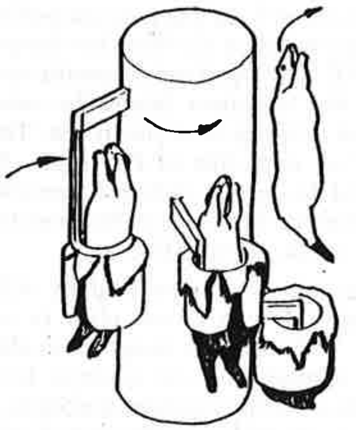

Fig. 3. Rotary pelter.

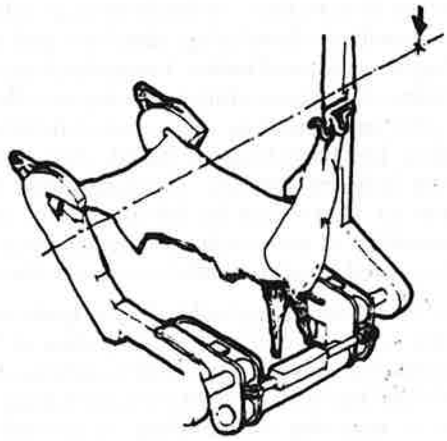

Fig. 4. Shoulder puller.

New Zealand's Mechanical Dressing Project has undertaken additional developments to further reduce the manpower needs for pelt removal. It developed the six head rotary pelting machine, which removes the pelt from the belly and lower back area as well as the hind legs. It also developed the shoulder puller, which removes the pelt from the shoulder and back regions (Fig.3).

Pelt removal from the sternum or brisket has been the subject of a number of new designs. Various hand tools have been developed over the years to improve productivity. Recently a brisket clearing machine has been developed, which simplifies the whole brisket workup, particularly within inverted dressing systems (Fig.4).

Automatic front and rear hock removal machines have also been produced, to fit in with the inverted mechanized concept developed by the New Zealand Project.

HEAD PROCESSING

The focus of developments in head skinning and brain and tongue removal has changed as the EEC regulations regarding head inspection have changed. Head skinning became necessary in 1975 when the head, in a totally skinned state, had to be presented with the carcass as part of carcass inspection. A number of head-skinning machines were developed, with the most successful being a machine based on a small shaft that gripped a flap of skin near the nose and removed the skin by a rolling action. This machine was used throughout most plants in New Zealand and Australia.

The regulation requiring heads to be presented with the carcass was partially relaxed in 1987, so that only those heads from which edible brains and tongues were saved needed to be inspected.

Developments to follow included automatic atlas joint severing, automatic head splitting, and automatic brain extraction (Fig.5).

PERFORMANCE OF A MECHANIZED SYSTEM

Table 2 gives the potential manning levels for a mechanized sheep slaughter and dressing system, based on developments so far, processing eight lambs per minute. This manning is in contrast with the traditional system, which needs a manning of 45 plus 15 assistants.

Even with this mechanized system, the accuracy of the manual work is still very important. A well-tuned machine will turn our poor quality product if the dressing workmanship of the carcass entering the machine is of a low standard.

Fig. 5. Brisket clearing machine

Fig. 6. Front hock remover.

Table 2. Chain manning for mechanized sheep and lamb slaughter and dressing.

Manning	Task
-	Auto Stun
4	Shackle, Open, Bleed
-	Auto Neck Break
3	Head Cheek, Remove
3	Y Cut, Push Flap
2	Clear Neck, Lift Shanks
-	Auto Wide to Narrow Transfer
-	Auto Front Trotter Remover
1	Load Brisket Clearer
3	Pull Brisket Piece, Y Cut Rear Legs
1	Load Shoulder Puller
1	Clear Breaks, Punch Tunnels
-	Auto Final Puller
1	Trim Anus
-	Auto Rear Trotter Remover
-	Auto Wash
-	Auto Brisket Cut
1	Gambrel
5	Evisceration
25	+ 11 Assistants

As yet, the quality performance of the better mechanized systems has not been able to match that of the best manual systems. In New Zealand, carcass downgrading of 4-5% and pelt strain incidence of 3-4% has been achieved; in the best manual systems these are 1% and 2% respectively.

Care must be taken to ensure that quality is gained from a mechanized system. The cost of a 1% increase in carcass damage incidence is equivalent to the cost of a butcher. Thus, if a system is introduced that saves four men, but carcass damage incidence moves from 1% to 5%, little economic advantage is gained.

COST SAVINGS

A rigorous assessment of the cost savings is difficult due to the experimental nature of some of the machines. An estimated cost saving of 50 cents per carcass is achieved by replacing a conventional dressing chain with an inverted manual dressing system, which uses only the final puller (Fig.2) of the machines listed in Table 2. The potential savings of incorporating all the machines listed in Table 2 and allowing for suitable servicing and replacement costs is a further 40 cents per carcass. These estimates are based on the overall carcass and pelt quality remaining the same, and on a normal daily kill of 3200 lambs per chain. No account has been taken of any associated costs.

One important feature of any dressing system is how chain speed (carcasses per minute) affects chain efficiency (output per man per day). Figure 6 gives results for the inverted manual system, predicted values for a system incorporating all the machines listed in Table 2, and a value for an average conventional chain operating at 8 carcasses per minute.

For both the inverted manual and the mechanized system, efficiency is maximal at about 9 carcasses per minute. At very low chain speeds (4 per minute), the difference between the mechanized and manual system is much less than at the optimal 9 carcasses per minute.

FUTURE TRENDS

The machinery developed for sheep dressing up until now has been based fairly heavily on mechanical principles. Electronic programmable logic controllers are used to control the mechanical actions and there is a minimum of feedback or sensing. Within mechanized chicken dressing not only are all the machines based on mechanical principles but in addition virtually all are mechanically by cams and rollers. Electronics are found only in the weighing and grading areas.

In future, however, rapid developments in the areas of electronic sensing, vision, and robotics are expected to affect carcass dressing. Initially these new developments will be used to control existing machinery for greater processing accuracy. We are told that within 4-5 years, vision systems will have a greatly increased capability, to the extent that 'off the shelf' models can be attached to processing machines. A vision system would be able to measure the various sizes and shapes of sheep and lamb carcasses without touching or contaminating the product; hence, its suitability is obvious.

For significant further manpower reductions in the sheep and lamb slaughter and dressing, tasks such as opening-up cuts and clearing cuts would have to be mechanized. At present these tasks are done by skilled workers, and significant research and development into tactile sensors, controlling multiple robot arms, would be needed for these tasks to be successfully mechanized. The magnitude of this problem would be the same order as that involved in shearing a sheep with a robot. The development of tactile and position-sensing elements is the fundamental requirement limiting progress at this stage, and any commercially effective solution is probably a decade away.