Final report:
British Beet Research Organisation Project 05/29

Safe methods of applying protective sheeting to beet clamps

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SUMMARY

This project examined ways of covering clamps whilst the operator remained at ground level, to prevent falls at height that have been associated with covering beet clamps in the past. In year one of a two year project, three designs were examined and one developed into a full working prototype model. This prototype was successfully tested on a 300t clamp of beet at Old Buckenham in Norfolk. The design consisted of a full clamp width roller mounted on two outer stands, these stands were secured under the bale clamp side walls. At one end the polyfelt cover was rolled up onto the roller and at the other end of the sheet a thin metal rod with two support wheels was attached to 80% of the width of the sheet. A rope was attached to this front bar and trailed to the far end of the clamp. The rope was then attached to a tractor mounted hydraulic drive reel that pulled the cover over the length of the clamp. To uncover the clamp, the hydraulic reel was attached directly to the roller via a mechanical shaft powered by tractor hydraulics.

In year two a hand winding system was developed to reduce capital costs, however, the gearing required to make manual covering possible, made the procedure slow and still required a high physical input by the operator. This hydraulic/mechanical design was also refined with an extra wheel fitted to the front bar and with further safety guarding. Drawings will be placed on the BBRO web site (appendix 1) to facilitate home building in the farm workshop.

INTRODUCTION

The HSE (Health and Safety Executive) have highlighted accidents in the workplace occurring from working at height and legislation has been introduced to reduce the number. At present sugar beet clamps that are covered, are done so manually by operators often walking over the clamp and pulling the cover across the clamp face. They are working on an uneven and unstable working surface at a height of approximately 2.5m, a possibly unsafe situation that requires an alternative method to eliminate the need to work off ground.

OBJECTIVE

To design, develop and provide a commercial alternative system that allows sugar beet clamps to be covered for protection against frost and uncovered after a frost period, without the need to work at height.

MATERIALS & METHOD

In year one, three designs were drawn-up and assessed as a desk exercise. These included using a mechanical roller arm attached to a fore-end loader arm, as sometimes used on mainland Europe. The second design was a basic manual system of ropes attached to the covering sheet at 5 m intervals along and across its length and width. The clamp sheet was fixed between the beet and bale wall on one side of the clamp and then pulled over the clamp

from the opposite side, from the ground, using the ropes. The rope was then used again, to pull the cover back, from the fixed side and again from the ground.

A working small scale model was made of the third design and this was developed into a full working model. Fabrication was carried out at the R&D development building at Bury St Edmunds sugar factory. A 10m long, 114mm diameter roller was constructed and mounted onto two stands. This was the equivalent to the full width of a clamp. The stands would be secured under the bale clamp side walls. One end of a polyfelt cover was fixed to, and rolled up onto, the roller. The other end of the sheet was attached to a 15mm metal rod, with two support wheels, along 80% of the width of the sheet. A rope was attached to this front bar to be trailed to the far end of a clamp. The rope was then attached to a tractor mounted hydraulic drive reel that pulled the cover over the length of a clamp. To uncover the clamp, the hydraulic reel was attached directly to the roller via a mechanical shaft powered by tractor hydraulics Listed in table 1 below are the materials used. The cover sheeting used was the standard commercial polyfelt sheet of 9.8m by 25m in length.

Table 1

Steel	Bearings	Hydraulic components	Miscellaneous
114mm/5mm/10m round hollow section	4 x 25mm plummer block housing unit	2.5 tonne 3000psi reversible hydraulic motor	50m 8mm polyprop rope
4mm/flat plate			1 wooden electric cable reel
50mm/ 3mm/20m flat bar			Hydraulic pipes and fixings
15mm mild steel round			A modified tractor 3 point linkage frame
100mm/50mm/3mm/ 3m hollow box section			2 of 4.00 x 8 pneumatic tyres and wheels
25mm/0.5m round			

In year two, following initial evaluation, an extra wheel was used to ease the flow of the coverer over the top of the clamp, and a mechanical winding mechanism was built and added to the hydraulic motor frame using a chain drive.

Garford Engineering were contracted to produce a CAD plan of the BS developed prototype for the final commercial design.

RESULTS

Design one, a mechanical mounted roller arm, was examined as a desk study. These are already manufactured for use in mainland Europe. However

the machine has a high capital cost (€41,000) and would be limited in practice to only covering clamps of up to eight metres in width, making it of limited use in the UK, where clamps are typically ten metres plus in width.

Design two, the manual rope pulling system from the side of the clamp was tested at Old Buckenham, however the effort required by the operator would likely cause body stress injuries. In addition the rope to cover sheet fixing brackets were of insufficient strength, so the design was not taken forward.

Design three, the mechanical/ hydraulic covering system work very well at the first attempt, although axis of the sheet rolling tube had to be exactly parallel to the clamp face or the sheet would roll to one side of the roller. Adjustment was carried out using a tractor fore-end loader to align the roller. Covering and uncovering proved simple and quick and without the operator needing to leave the tractor seat, once the rope had been attached to the roller drive shaft. If the tractor and hydraulic reel were not placed centrally at the end of the clamp before covering starts, the sheet pulled to one side. However, if the tractor operator repositioned the tractor and reel, the sheet realigned as it pulled over the clamp.

The two wheels attached to the front pulling bar were slightly too far apart and allowed the bar to pull against the beet on top of the clamp, increasing the pulling force required. The introduction of a third central wheel in year two of the project stopped this from happening, it reduced the drag and allowed the coverer to move more evenly across the clamp.

A mechanical hand operated winding system was also developed in year two as a cheaper alternative to the tractor hydraulic driven reel system. To make hand winding possible very low gearing was required for an operator to work comfortably. But this made the task very time consuming and still involved a high level of physical effort (that may lead to operator fatigue if more than one clamp had to be covered).

In year one, the roller securing brackets were placed directly under the Heston bale walls and these provided a secure anchorage point. In year two the brackets were placed under the wooden pallets that were under the Heston bale wall. The pallets subsequently gave way and broke when the sheet was pulled out to cover the clamp. This resulted in a very poor fixing and to uncontrollable movement of the stands. This was overcome by inserting solid wood sections into the pallet layer.

As part of a safety assessment, two hand trapping points were identified at the outer edge of the sheet where it rolls onto the roller during uncovering. It was also noted that the loose anchorage points could provide a foot trapping place.

The prototype was drawn as a commercial design by Garford, Engineering using CAD software. These drawings will become commercially available (Appendix 1) and are to be lodged on the BBRO website..

DISCUSSION

The prototype of design three allows clamps to be covered and uncovered by an operator at ground level. It has also mechanised the operation, making the task physically much easier. The job can now be carried out from the tractor seat as a one man operation, where required.

Design three was seen as the appropriate design to be taken through to commercial status. However this design would have a retail purchase price of approximately £650 to £800 plus the cost of the polyfelt sheet (£180), for a fully assembled unit. This level of investment was seen as a restricting factor in the commercial uptake of the unit. Therefore it was decided, via Garford Engineering, to offer the unit as a flat pack system at approximately £400 to £500 and as an online design, through the BBRO web site, for fabrication by growers in their own workshops.

A large part of the investment is in the hydraulic motor and piping, however this part of the equipment can be used to cover and uncover many different clamps and could be used by a contractor offering a clamp covering/ uncovering service or by a local group of farmers.

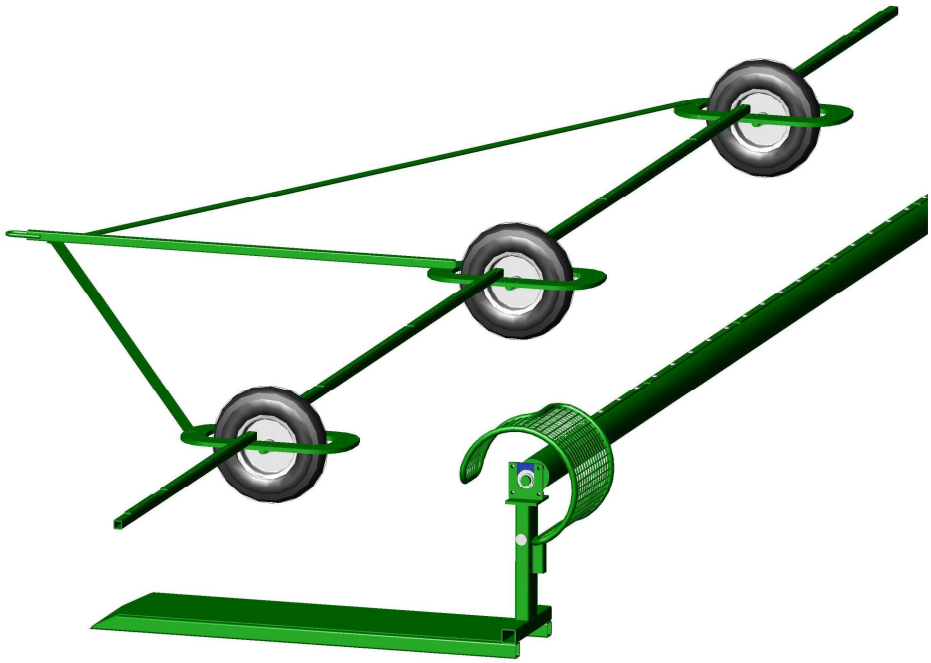
Although this operation should be seen as one man job, lowering labour costs, the appropriate safety guarding has been incorporated into the commercial version to ensure full protection to all present.

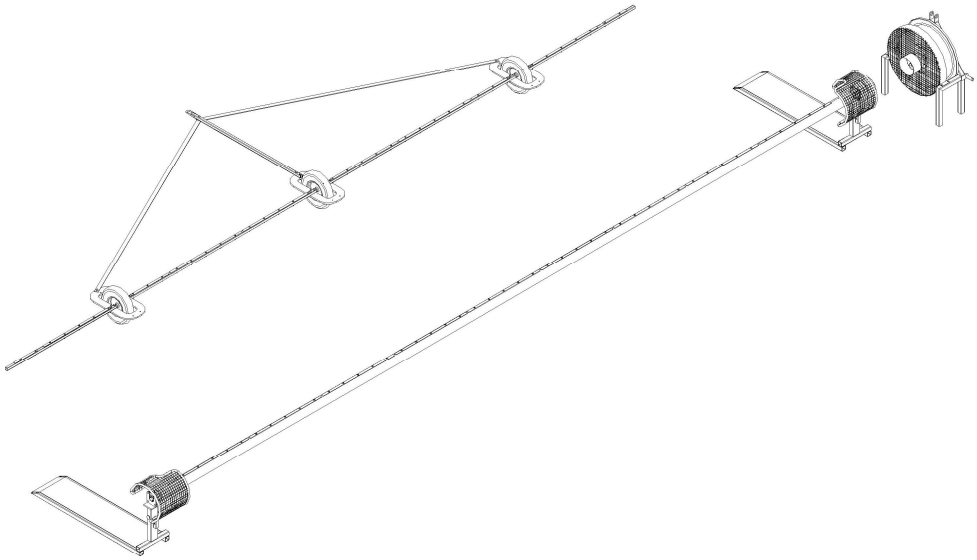
Incorporation of this automated covering approach will require changes to currently recommended practice. The roller unit and sheet will in future need to be put out as the clamp walls are being built, and the pallets under the bales securing the unit must be removed or replaced with a solid block, so that this or the bale and not the pallet is securing the unit stands. These units can be left out with the sheet rolled up from one season to the next with a life span up to ten years. It must also be ensured that the roller is placed exactly parallel with the clamp end for even distribution of the sheet onto the roller.

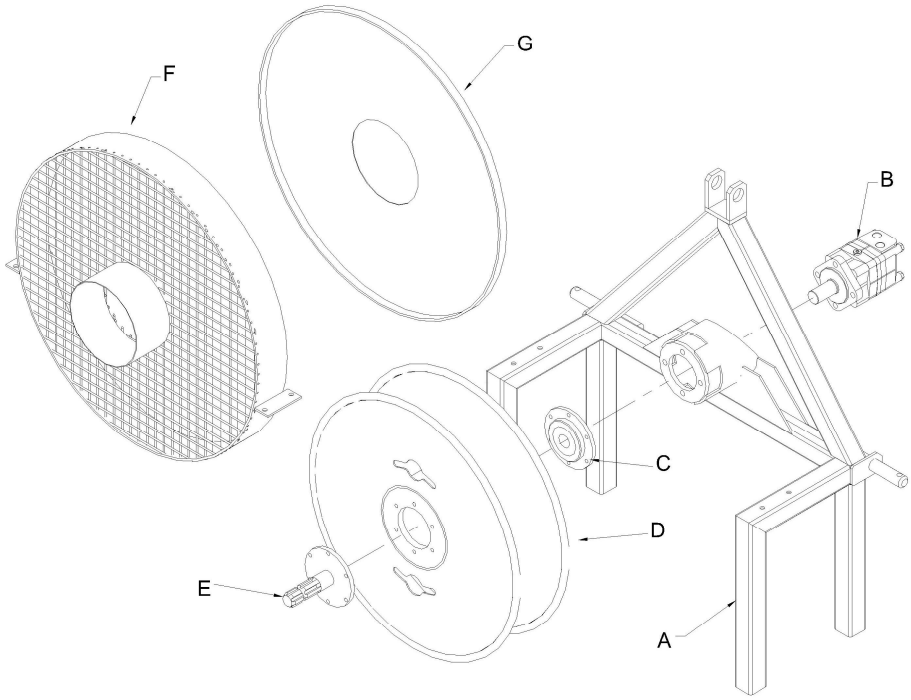
To date the mechanism has only been tested on the standard BBRO clamp design. However, in the UK there are a variety of commercial clamp shapes and sizes, and it may be that more testing is required to ascertain the performance on these other designs of clamp. There may also be a need to examine the possible use of larger individual units, or units working in tandem, to match a range of different clamp shapes.

Appendix 1

Commercial Design



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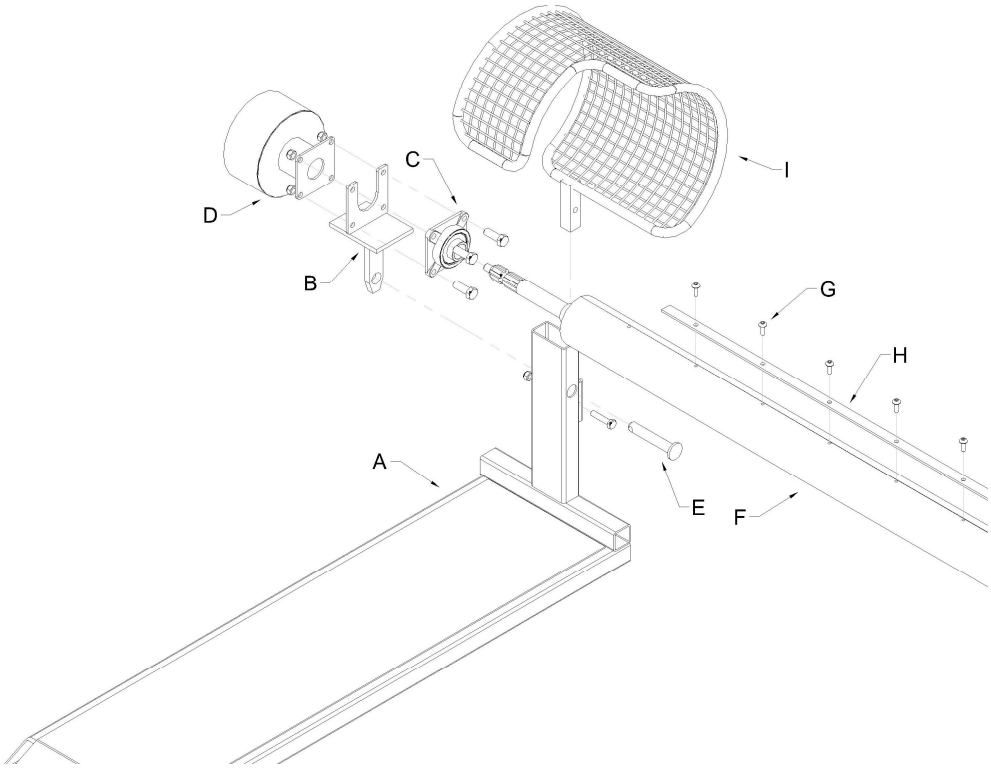
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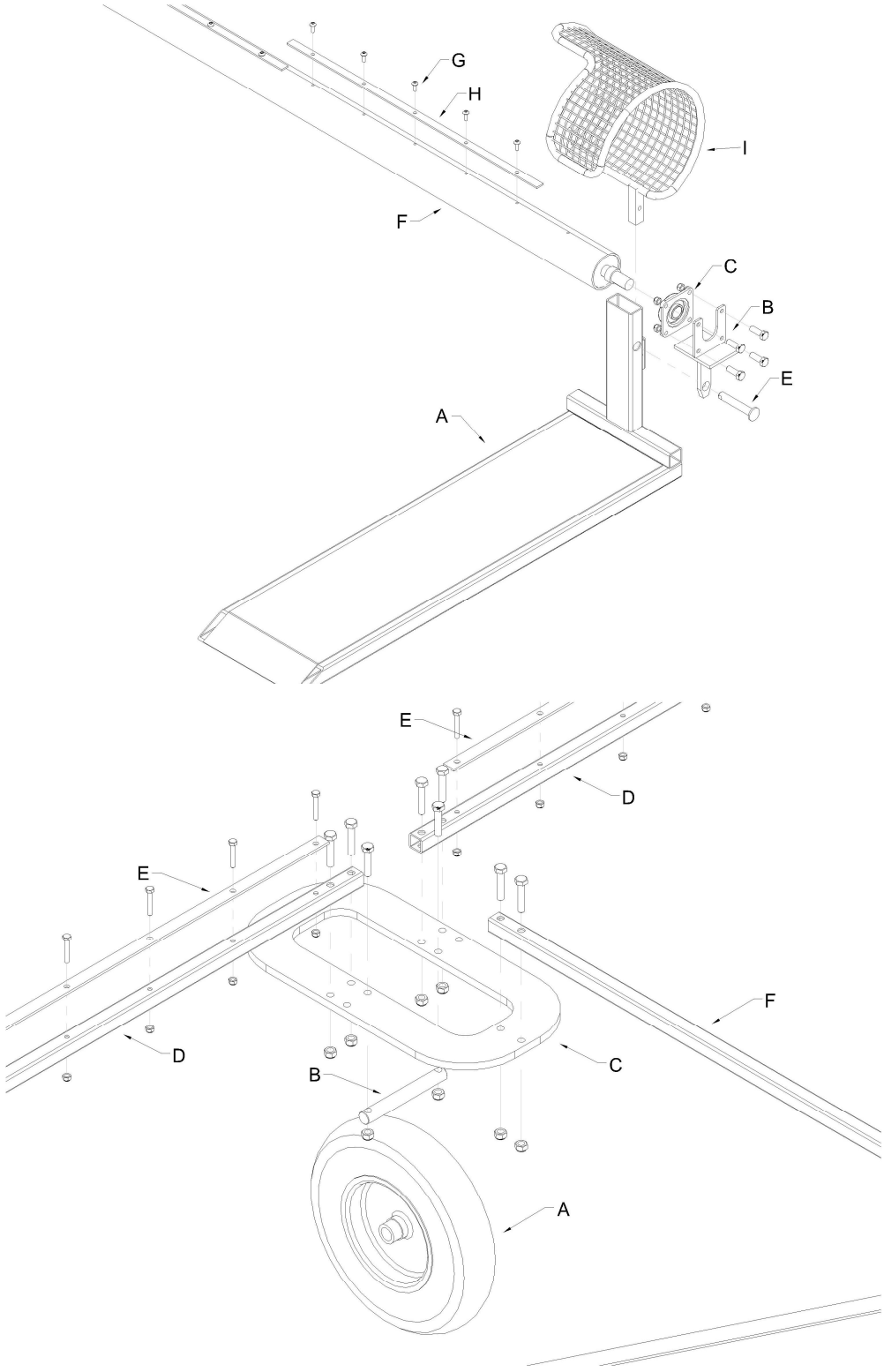
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