HARVESTING OF LIMA BEANS FOR PROCESSING
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Introduction and Review of Literature
Processed vegetable production is an essential component of agricultural industry in the Mid-Atlantic region. In 1994, Delaware lead the nation with over 5000 ha of lima beans grown for processing.

Most processors in the region use lima beans as their primary crop. Historically, high margins for lima beans and limited competition in other regions have allowed processors to remain profitable. However, many issues threaten the long term sustainability of the industry. Current problems already facing most processors include the enormous quantities of water required during processing that must be treated and discharged without impacting the environment, the large amounts of yield that are lost during harvesting and the excessive amount of trash and foreign materials that are incorporated into the vegetables during harvest thus requiring additional processing and cost to ensure a clean, consistent product.

Currently all lima beans grown for processing are harvested mechanically, most with pod stripper combines. Advances over the last two decades in the harvesting of lima beans include multi-beater threshing systems for additional throughput capacity of harvesters, six wheeled and tracked harvesters for improved performance in wet conditions, electrohydraulic systems which provide the operator with increased control of key machine functions as well as the stripper head for once over harvesting. Little work has been done with pod stripper combines to quantify the effects and interactions of harvester operation, growing practice and crop variety on harvest loss, product cleanliness and product processing characteristics. It is the goal of this investigation to initiate a long term program to evaluate and improve the production, harvesting and processing of lima beans in the Mid-Atlantic region.

Objectives
The primary goal of this project is to initiate a program to enhance the sustainability of the vegetable processing industry as a viable enterprise in the Mid-Atlantic region. To achieve this, a study was initiated to first evaluate current technology and practices for growing and harvesting lima beans. The specific objectives of the study were to i) measure lima bean harvest losses and harvested product quality under a wide range of practices and conditions in the Mid-Atlantic region, ii) determine the interactions between cultural practices, crop varieties, harvester operating parameters, harvest loss and harvested product quality, and iii) develop recommendations which reduce field loss and processing water and cost requirements.

Results for Baby Lima Beans
All lima beans evaluated were planted with a row crop planter in 76.2 cm rows. Average forward speeds for combines with small head widths (3.28 m) was 1.49 km/hr. Combines with larger head widths (3.9 m) averaged 1.04 km/hr. The resulting theoretical field capacities using effective head widths averaged 0.37 ha/hr and 0.44 ha/hr for the small and large head combines, respectively.

The average total field losses (i.e., the sum of head, tailing, and apron losses) for all the tests conducted in baby lima beans indicates losses were significantly higher at the 5% level for the variety M-15, a plant that is shorter than other varieties and exhibits a low pod set plant architecture. The majority of field losses were at the head of the combine. The effect of field levelness on the type of head loss was measured. Levelness across the front of the harvester was classified as flat (<37 mm), moderate (between 37 and 57 mm) and unlevel (>57 mm). Pods left on the plant were significantly higher at the 5% level for unlevel field conditions for each of the varieties evaluated.
The effects of harvester speed on the losses at the head were measured. Forward speed was classified as slow (<1.2 km/hr), medium (between 1.2 and 2 km/hr) and fast (>2 km/hr). Both loose bean loss and the pods left on the plant were not significantly affected at the 5% level by harvester speed. Loose pod loss at the head significantly increased with slower combine speeds.

Combines from each of the three manufacturers averaged over 270 kg/ha total harvest loss which was at least 12% of the commercial yield. Field losses for combines from manufacturers identified as A and C were predominantly head losses. The head losses from manufacturer A were significantly higher at the 5% level compared to the other combines evaluated. Apron and tail losses accounted for slightly over half of the field losses for combines from manufacturer B.

Average trash content in the harvested product as a percent of harvested yield for each of the combines tested was measured. Trash included stems, leaves, pods, stones, and other foreign materials. Trash content was at least 9.8% for each of the combines tested. Combine A demonstrated significantly higher trash contents than combines B and C. The bean varieties 184-85 and M-15 each exhibited significantly higher trash content at the 5% level compared to the variety 8-78. This may be explained by the fact that both varieties tended to exhibit small, low pod set type plant architectures which required higher picking real speeds and lower head heights. Surprisingly, the effect of field levelness in front of the combine had no significant effect on trash content. There was no correlation of trash content with either the commercial yield or the hand pulled yields. In addition, there was no significant effect of harvesters speed on trash content.

Recommendations

The results indicate pod stripper combines should be operated at forward speeds which are as high as possible to limit head loss in lima beans. Forward speed should be limited by the throughput capacity of the combine and not reduced to recover additional product at the head of the combine. Improved field levelness in lima beans will reduce the loss of pods at the head. Significant reductions in the trash content of harvested lima beans can and will most likely be achieved with i) modern and improved combines and ii) genetically enhanced plants with architectures that are better suited for pod stripper combines.

Conclusions

Mechanical pod stripper combines have become the predominant method of harvesting lima beans for processing in the Mid-Atlantic region. Field losses for lima beans harvested with these machines are high, averaging over 270 kg/ha (12% of commercial yield). For most combines evaluated, a majority of the losses occurred at the head of the combine where the pods are stripped from the plant. Reduced combine forward speed and unlevel field conditions each significantly increased head loss in lima beans. Field losses in lima beans for combines from two manufacturers were predominantly head losses. The head losses from one of those manufacturers were significantly higher at the 5% level compared to the other combines evaluated. Apron and tail losses accounted for slightly over half of the field losses from combines from a third combine manufacturer.

Trash content in lima beans averaged 9.8% of the harvested product. One combine manufacturer exhibited significantly higher trash than the other two combines evaluated. Both 84-85 and M-15 lima bean varieties exhibited higher trash contents than the 7-78 variety. In addition, field loss in the M-15 variety was significantly higher than the other lima bean tested.

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