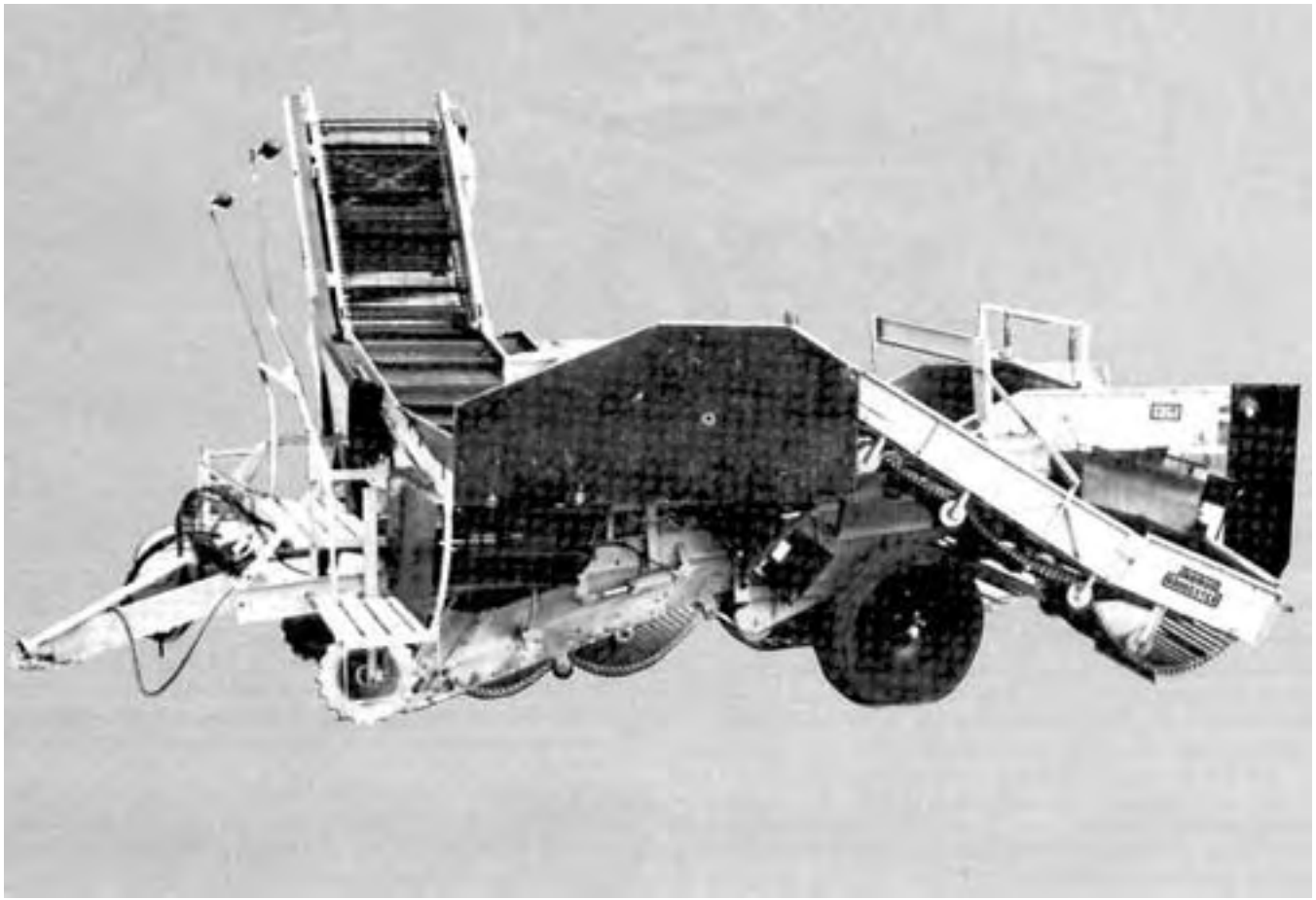
Evaluation Report No. E0878
Printed: July, 1979
Tested at: Portage la Prairie
ISSN 0383-3445

Evaluation Report 126



Thomas Model 635 Potato Harvester

A Co-operative Program Between
ALBERTA FARM MACHINERY RESEARCH CENTRE
PAMI
PRAIRIE AGRICULTURAL MACHINERY INSTITUTE

THOMAS MODEL 635 POTATO HARVESTER

MANUFACTURER:

Thomas Equipment Limited
Centreville
New Brunswick
E0J 1H0

DISTRIBUTOR:

A.M. Briggs Limited
P.O. Box 273
Portage la Prairie
Manitoba
R1N 3B5

RETAIL PRICE:

$28,152.00 (July 1979, f.o.b. Portage la Prairie, Manitoba with standard contour bar spade, optional trash cutting coulters, power steering, powered trash roller, deviner roller, and long clod roller table, as well as front and rear trash conveyors under the picking table.)

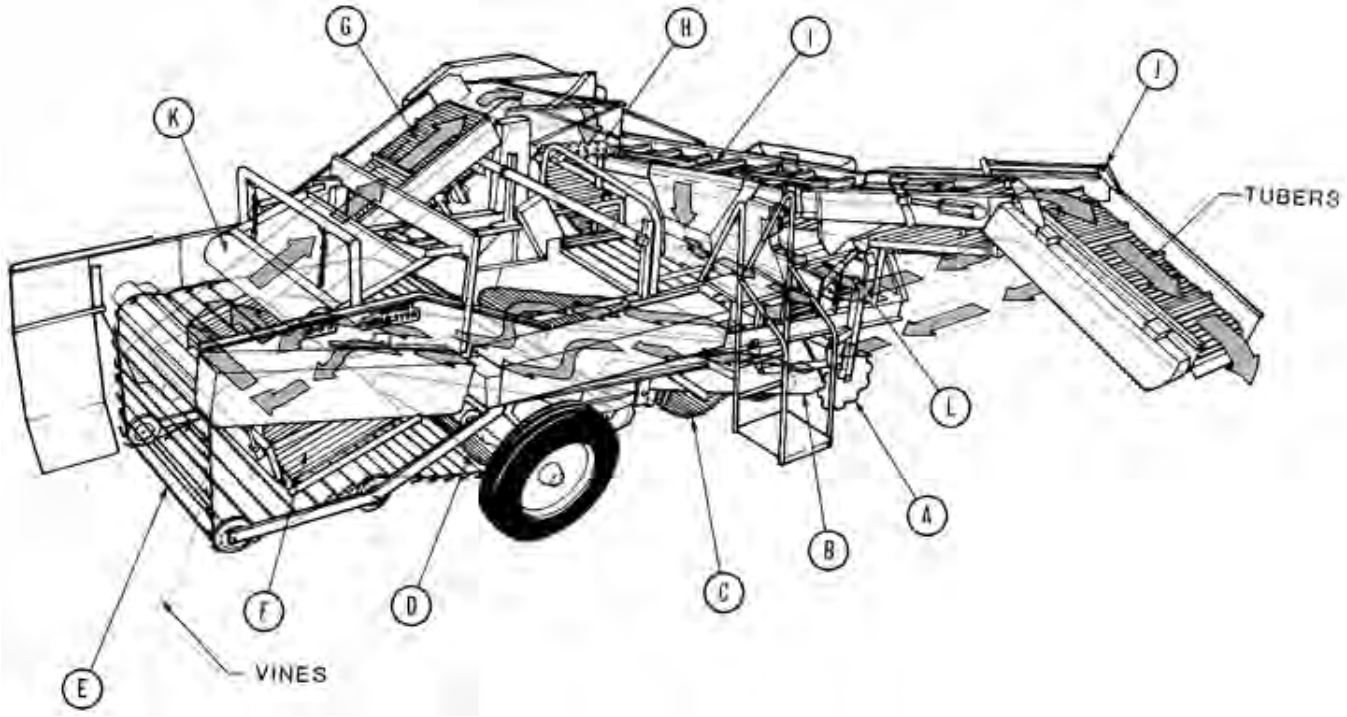


FIGURE 1. Thomas 635 Potato Harvester: (A) Coulters, (B) Spade, (C) Primary Digger Chain, (D) Secondary Digger Chain, (E) Deviner, (F) Cross Conveyor, (G) Elevating Conveyor, (H) Clod Roller Table, (I) Sorting Table, (J) Delivery Boom, (K) Stripper Roller, (L) Trash Conveyors.

SUMMARY AND CONCLUSIONS

The functional performance of the Thomas 635 Potato Harvester was very good in loam and sandy soils with low to normal moisture contents. Performance was fair in wet loam soils.

Workrate was governed by the separating ability of the primary and secondary digger chains and depended primarily on soil conditions. Appropriate ground speeds in loam soil, at optimum moisture content, ranged from 3.5 km/h (2.2 mph) when harvesting two rows, to 2 km/h (1.2 mph) when used in conjunction with a potato windrower and harvesting six rows. Corresponding workrates in average crop yields of 22 t/ha (10 ton/ac) were 12 t/h (13.2 ton/h) when harvesting two rows, and 18 t/h (20 ton/h) when harvesting six rows. Workrates were reduced by about 50% in moist, heavy soils.

Deviner performance was very good in most field conditions. Tuber carryover varied from 1% in ideal field conditions to 5% in fields with very heavy green vines. In normal soil conditions, clod table performance was very good and most tubers and clods less than 40 mm (1.6 in) thick were removed. In wet sticky soils, soil buildup on the clod rollers severely reduced clod separation effectiveness.

Typical samples of harvested potatoes showed 69% undamaged tubers, 11% slightly skinned, marketable tubers, 9% moderately bruised, unmarketable tubers and 11% severely damaged tubers. When used in conjunction with a potato windrower, an average of 30% of the harvested potatoes were sufficiently damaged to be unmarketable. To reduce bruise damage, it was important to keep the digger chains well loaded with soil and to operate at the maximum permissible feedrate.

Plugging was infrequent in dry soil with relatively dry vines. In wetter soil, with tough green vines, the coulters often did not completely cut the vines, which led to hairpinning on the spade dividing boards and frequent cleaning stops.

The Thomas 635 was easy to maneuver. The optional power steering attachment was very effective on short headlands. Operator visibility of the delivery boom, spade, coulters and primary digger chain, was very good. The picking crew platforms restricted view of the deviner and secondary digger chains.

A tractor with a minimum 85 kW (115 hp) power take-off rating should have ample power reserve to operate the Thomas 635 in most soil conditions.

The Thomas 635 was convenient to service and lubricate and transported well. All drives were well shielded. The right tire was overloaded by 30% while the left tire was overloaded by 44% at normal transport speeds. No operator's manual was available.

Several mechanical problems occurred during the 230 hour test period: Repeated idler sprocket failures occurred on the clod roller drive assembly, necessitating field modification. One set of primary digger chains wore sufficiently to require replacement.

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Modifications to improve coulter cutting performance in adverse conditions, thereby reducing hairpinning of uncut vines on the spade dividing boards.
2. Modifications to the clod roller drive assembly to reduce drive durability problems.
3. Modifications to the clod roller drive shield to improve ease of access to the drive assembly.
4. Providing access holes in the drive shields to facilitate chain lubrication.

5. Providing an operator's manual complete with a suggested lubrication schedule.
6. Supplying a slow moving vehicle sign as standard equipment.
7. Providing sorting table lights as optional equipment.
8. Equipping the harvester with tires with a higher load rating.
9. Chief Engineer -- E.O. Nyborg
Senior Engineer -- J.C. Thauberger
Project Engineer -- G.R. Pool

THE MANUFACTURER STATES

With regard to the recommendations:

1. We will analyse your recommendations for possible implementation in future production.
2. All present production harvesters are now equipped with a slow moving signs.

GENERAL DESCRIPTION

The Thomas 635 (FIGURE 1) is a two row, power take-off driven, pull-type potato harvester, with a 1.6 m cutting width.

The spade moves through the soil beneath two rows of potatoes, lifting a mass of soil, tubers and vines onto the primary digger chains. A portion of the soil falls through the primary digger chains, while the remaining soil, tubers and vines are delivered to the secondary digger chains. A larger pitch deviner chain, which rotates outside the secondary chains, carries vines and trash out the back of the harvester. The secondary chains complete loose soil separation and deliver tubers and soil clods to the cross conveyor. Tubers and clods are conveyed up an elevating conveyor to a clod roller table where a series of rollers remove small tubers and clods. Final sorting and cleaning takes place on a hand sorting table, with provision for up to six labourers. Sorted tubers are finally delivered to the receiving vehicle on an adjustable conveyor boom.

The harvester drive is controlled by the tractor power take-off clutch. Conveyor speed is regulated through a three-speed gearbox. Hydraulic controls adjust spade depth as well as inner and outer delivery boom height. A minimum 85 kW tractor, with 540 rpm power take-off and at least one hydraulic outlet, is needed to operate the Thomas 635.

The test machine was equipped with the standard contour bar spade, optional trash cutting coulters, power steering, powered trash roller, deviner roller, and long clod roller table, as well as front and rear trash conveyors under the picking table.

Detailed specifications are given in APPENDIX I.

SCOPE OF TEST

The Thomas 635 was operated in the soil conditions shown in TABLE 1 for 230 hours while harvesting about 175 ha of Netted Gem potatoes. It was evaluated for ease of operation and adjustment, rate of work, quality of work, power requirements, operator safety and suitability of the operator's manual. It was powered with an International Harvester 1086 tractor, and was used in conjunction with a Thomas 660 potato windrower for most of the test.

TABLE 1. Operating Conditions

Soil Texture	Hours	Field Area (ha)
Loam	185	131
Fine Sandy Loam	35	36
Loamy Fine Sand	10	8
Total	230	175

RESULTS AND DISCUSSION

EASE OF OPERATION AND ADJUSTMENT

Hitching: Since the hitch weight was 1300 kg, a jack was needed to hitch the Thomas 635 to a tractor. Alternately, the hitch could usually be raised sufficiently by first connecting the hydraulic hoses and lowering the spade onto the ground with the hydraulic system.

The Thomas 635 was powered by a standard 540 rpm power take-off shaft from the tractor. It was equipped with its own hydraulic control valve assembly (FIGURE 2) which connected to one set of outlets on the tractor hydraulic system and which could be mounted at a convenient location on the tractor.

FIGURE 2. Hydraulic Control Valve Assembly.

Controls: Access to hydraulic controls was convenient since the control assembly could be mounted at a suitable location on the tractor. Individual hydraulic controls were provided for spade depth, delivery boom height and optional power steering.

The conveyor speeds could easily be adjusted to suit soil conditions by means of a three-speed gear box. The gearshift lever was located on the front of the harvester. The operator had to stop the harvester and dismount from the tractor to shift gears. Speed ratios of 0.83:1, 1:1 and 1.54:1 were suitable for all soil conditions encountered in the test.

Indicators, on the front of the harvester showing wheel orientation, spade depth, and transmission gear setting, were effective and easy to view.

Maneuverability: The Model 635 was equipped with optional power steering, permitting the harvester wheels to be steered from the tractor seat. The power steering was very effective. The harvester could be turned on most headlands without stopping and backing. On some very short headlands, it was still necessary to back the harvester to align it with the rows.

Operator Visibility: Monitoring delivery into the receiving truck was easy as there was very good visibility of the delivery boom from the tractor seat. The tractor operator had a clear view of the spade, coulters and primary digger chains. The picking crew platforms restricted the view of the secondary digger chains and the deviner chain.

Night Operation: No lighting system was provided for night operation. Standard tractor lights provided sufficient illumination for the tractor operation, however, two lights had to be installed above the picking table to provide illumination for the picking crew. It is recommended that the manufacturer consider providing picking table lights as optional equipment.

Plugging: Hairpinning of uncut vines, on the spade dividing boards, occurred in a variety of field conditions. Tough green vines as well as bunches of dry vines sometimes were not completely cut by the coulters, allowing the uncut vines to hairpin on the dividing boards. Plugging was infrequent in dry soil with relatively dry vines. In wetter soils, with tough green vines, frequent cleaning stops were needed. Coulter cutting effectiveness was improved somewhat, by placing spacers on the coulter lift arms (FIGURE 3) to increase the coulter spring force. Observation of the plugging pattern indicated that coulter effectiveness could probably be increased by placing the coulters further ahead of the spade. It is recommended that the manufacturer modify the coulter assembly, possibly by providing heavier coulter springs and by positioning the coulters further forward, to improve vine cutting effectiveness in adverse conditions.

Clod Roller Table: Performance of the clod roller table was very good in dry and sandy soils. It effectively removed small potatoes and clods less than 40 mm thick while larger potatoes and clods were delivered to the sorting table for hand sorting.

The clod roller table plugged frequently in moist, sticky soil. Sticky soil adhered to the rollers, increasing roller diameter, rendering the clod table ineffective, and causing most clods to be delivered to the sorting table.

The clod roller table was positioned on the left of the harvester

and discharged clods and small potatoes onto the un-harvested row of potatoes, adjacent to the harvester. Although this did not create any noticeable problems, it meant that much of the sorted material, which was discarded by the clod rollers on one round would be picked by the harvester on the subsequent round. This did not occur when the harvester was used in conjunction with a potato windrower as, in this case, the clod roller discharge was deposited onto rows, which had previously been dug by the windrower.

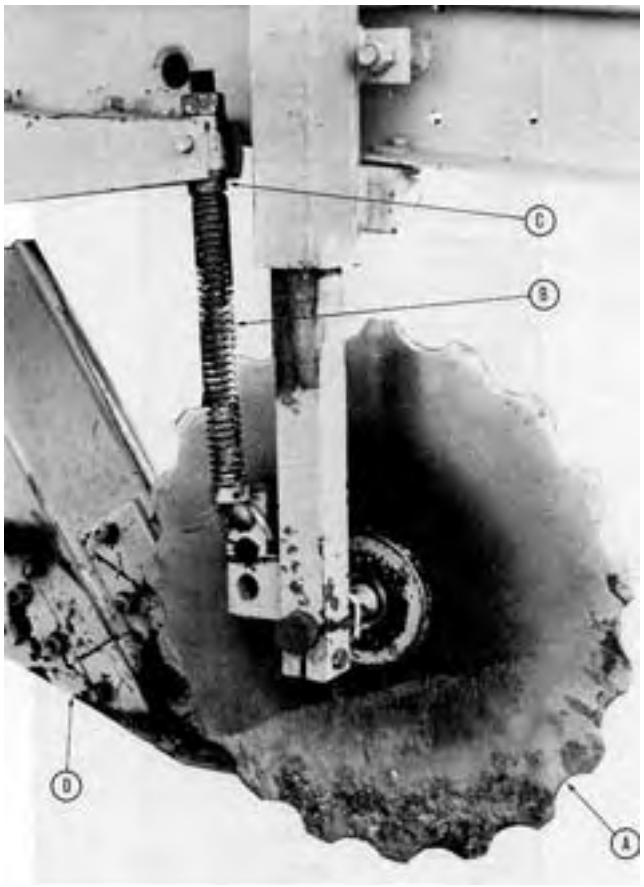


FIGURE 3. Coulter Assembly: (A) Coulter, (B) Coulter Spring, (C) Spacer Added to Increase Spring Force, (D) Spade Dividing Board.

Cleaning: Frequent machine cleaning was necessary, especially in wet, sticky soil, to maintain optimum soil separation. Wet soil adhered to conveyor links reducing the conveyor pitch, hindering soil separation. Similarly, soil that adhered to the clod rollers had to be scraped off periodically to ensure effective clod removal. At the row ends, it was often necessary to clean soil and vines from the spade and coulters.

Transport: The Thomas 635 towed well at speeds up to 25 km/h on smooth gravel and paved roads. Operator visibility to the rear was adequate.

Lubrication: The Thomas 635 had 23 pressure grease fittings, as well as 14 roller chains, that required periodic lubrication. Daily servicing of all lubrication points took about one-half hour. A lubrication schedule was not specified by the manufacturer. The universal joints, in the angled power shaft beneath the picking platform, required frequent lubrication, due to high loads and dirty operating environment.

Many shields had to be removed to lubricate the roller chains. The large shield covering the clod table drive (FIGURE 4) was particularly cumbersome and heavy to remove. Lubrication access holes in the chain shields would have greatly facilitated chain servicing.

It is recommended that the manufacturer provide a lubrication schedule, consider providing access holes in chain shields to facilitate lubrication and consider modifying the clod roller drive shield to improve ease of access to the drive assembly.

Rate of Work: Workrates were governed by the separating ability of the primary and secondary digger chains and depended primarily on soil type and moisture content. Workrate was influenced by crop yield to a lesser extent. Average workrates were increased by about 50% when the harvester was used in conjunction with a two-row potato windrower and four rows were double windrowed onto the two rows to be picked by the harvester. As shown in TABLE 2, average workrates in 20 to 24 t/ha Netted Gem potatoes, in loam soil at optimum moisture content, varied from 12 t/h, for two-row harvesting to 18 t/h for six-row, double windrowed harvesting. Corresponding average ground speeds were 3.5 and 2 km/h respectively. Workrates in moist, heavy soils were about 50% less than those shown in TABLE 2.

FIGURE 4. Clod Roller Drive Shield.

TABLE 2. Average Workrates.

Number of Rows Picked	Yield	Speed	Workrate	
	t/ha	km/h	ha/h	t/h
2	24	3.5	0.5	12
6 (double-windrowed)	20	2.0	0.9	18

The limiting factor for two-row harvesting was the rate of soil removal from the primary and secondary digger chains. At higher ground speeds, soil accumulated on the digger chains, resulting in carryover to the rear cross conveyor. For six-row operation, workrate was limited by the physical capacity of the harvester and its crew. In high yielding fields, ground speed had to be reduced to prevent rollback on overloaded conveyors and to allow the six-man picking crew sufficient time to sort.

QUALITY OF WORK

Soil Separation: The 40 mm pitch, primary and secondary digger chains are designed to separate soil from the potato tubers. Soil separation was very good in all soil conditions, other than in heavy, wet soil. In heavy, wet soil, the chain links became coated with soil and small roots reducing the gap between individual links, causing some soil to be carried over to the rear cross conveyor. This is a typical occurrence with most potato harvesters in adverse soil conditions.

Devining: A 128 mm pitch deviner chain, rotating around the secondary digger chains, was used to remove vines and trash. Deviner performance was very good in most field conditions, with acceptable tuber carryover. Average carryover losses varied from 1% in ideal field conditions to 5% in fields with very heavy green vines. The optional deviner stripper roller effectively reduced carryover of large potatoes, in fields with heavy green vines.

In fields heavily infested with wild oats, some wild oats fell through the deviner chain and were delivered to the rear cross conveyor, causing wrapping on the cross conveyor drive components. The optional powered trash roller, located at the discharge end of the cross conveyor, was effective in reducing the amount of trash or weeds delivered to the elevating conveyor.

Clod Separation: In normal soil conditions, the clod roller table effectively removed clods and potatoes less than 40 mm thick.

The optional long table had sufficient capacity to suit harvester capacity. In sticky, wet soils, soil buildup on the clod rollers severely reduced the effectiveness of the clod roller table.

Manual Sorting: As with most potato harvesters, the quality of the product delivered to the receiving truck depended primarily on the ability of the hand sorters, (FIGURE 5) to perform final sorting. The sorting table had room for six people. The effectiveness of the hand sorting and the number of labourers needed was governed by the harvesting rate and by soil conditions. In dry, lumpy soil, which

broke into large clods, the harvester workrate depended mainly on the manual sorting rate.

FIGURE 5. Hand Sorting Table.

Bruising: When using the Thomas 635 in standard two-row picking, an average of 20% of the harvested potatoes were sufficiently damaged to be unmarketable. The parameter used to determine damage was bruising, which included blackspot as well as shatter bruise*. Typical samples of harvested potatoes (FIGURE 6) showed 69% undamaged tubers, 11% slightly skinned but marketable tubers, 9% moderately bruised tubers and 11% severely bruised tubers. The latter two categories were unmarketable and would spoil in storage.

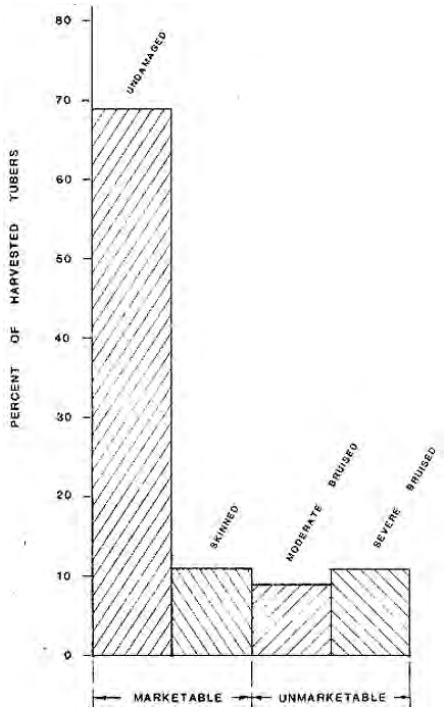


FIGURE 6. Typical Bruise Damage in Netted Gem Potatoes.

When used in conjunction with a potato windrower and when harvesting six rows, as a result of double windrowing, an average of 30% of the harvested potatoes were sufficiently damaged to be unmarketable. Additional damage when using a windrower was the result of bruise damage caused by the windrower.

Bruise damage occurred primarily to the larger potatoes. Damaged tubers, on an average, weighed 195 g (about 20%) more than undamaged tubers. The ratio of digger chain speed to ground speed did not significantly affect bruise damage. Keeping the conveyor chains well loaded with soil and operating at maximum possible feedrates, both were important in reducing tuber damage.

Power Requirements: Average power take-off input was about 22 kW. Average d raft power input varied from 11 kW at 1.6 km/h to 26 kW at 3.6 km/h. A tractor with minimum 85 kW power take-off rating should have ample power reserve to operate the Thomas 635 in most conditions. In selecting a tractor, consideration should be given to the fact that the tractor must support a 1300 kg hitch weight. In addition, tractor tire size should be adequate to provide sufficient flotation to prevent tire damage to un-harvested tubers, in soft soil.

PAMI T7719-R78, Detailed Test Procedures for Potato Harvesters.

OPERATOR SAFETY

All power shafts, drive chains and sprockets on the Thomas 635 were well shielded for picking crew safety. If the normal safety precaution, of disengaging the power take-off before leaving the tractor was followed, all servicing and adjustments were safely performed.

The picking crew had to exercise extreme caution at their hazardous task. Clothing had to be tight fitting and belted to prevent it from being caught in the moving conveyor chain. Guard railings were slightly less than adequate, being simply a length of pipe, around the platform, supported at waist level.

No safety instructions were provided with the Thomas 635. In addition, no safety decals were affixed to the harvester to point out possible safety hazards.

The tire loads on the Thomas 635 exceeded the Tire and Rim Association maximum load rating for 9.00 x 24, 8-ply implement tires. The right tire was overloaded by 30% while the left tire was overloaded by 44% at normal transport speeds. It is recommended that the manufacturer equip the harvester with tires that satisfy Tire and Rim Association load rating requirements.

Caution had to be used when transporting the Thomas 635 due to its large 5.4 m transport width. It was not equipped with a slow moving vehicle sign for transport on public roads. It is recommended that a slow moving vehicle sign be supplied as standard equipment.

OPERATOR'S MANUAL

No operator's manual was available for the Thomas 635. It is recommended that a suitable operator's manual be provided.

DURABILITY RESULTS

TABLE 3 outlines the mechanical history of the Thomas 635 during 230 hours of operation, while harvesting about 175 ha of potatoes. The intent of the test was evaluation of functional performance. The tabulated failures represent those, which occurred during functional testing. An extended durability evaluation was not conducted.

TABLE 3. Mechanical History

Item	Hours	Field Area (ha)
Four sprockets on the clod table drive were severely worn requiring replacement at	20	13
The clod table drive assembly failed and was redesigned at	115	81
The bracket holding the power steering hydraulic ram to rear axle broke and was replaced at	125	87
Both primary digger chains were worn, requiring replacement at	175	135
The roller chain from the gearbox to the clod table drive broke and was replaced at	180	138
The centre hooks of the primary digger chains caused damage to the rubber covering on the deviner chain links	throughout the test	
Many rubber flights on the elevating conveyor and on the delivery boom were badly torn, at their ends, by	end of test	
The elevating conveyor chain had almost worn through the sides of the elevator housing at	end of test	

DISCUSSION OF MECHANICAL PROBLEMS

Clod Table Drive: The clod table was equipped with a complicated drive arrangement. A single roller chain drove the 16 rollers by passing over 16 d rive sprockets and nine idler sprockets (FIGURE 7). Deformation of the idler mounts during operation resulted in chain misalignment. Slight chain wear resulted in rapid idler sprocket wear due to the large chain wraparound the idler sprockets. Repeated idler sprocket failures necessitated drive modification.

The clod table drive was modified by PAMI, as shown in FIGURE 8, to reduce chain wrap around the idler sprockets and to reduce deformation problems. The modified drive performed well for the last 115 hours of field operation. It is recommended that the manufacturer modify the cold table drive assembly to reduce durability problems.

Elevator Flights: After 230 hours of use, many rubber flights on the elevating conveyor and delivery boom were badly torn at their

ends (FIGURE 9). The damaged flights caused some tuber roll back on elevating conveyor.

FIGURE 7. Original Clod Table Drive Assembly.

FIGURE 8. Modified Clod Table Drive Assembly.

FIGURE 9. Torn Elevator Flighting.

APPENDIX I
SPECIFICATIONS

Make:	Thomas
Model:	635
Serial Number:	70021
Manufacturer:	Thomas Equipment Ltd Centreville, New Brunswick
Coulters:	
-- type	notched blade
-- diameter	610 mm
-- depth control	integral with spade depth control
Digger Spade:	
-- type	standard contour
-- width	1630 mm
-- depth control	hydraulic ram
Primary Digger Chain:	
-- type	dual offset chain
-- number of links	120
-- length	4800 mm
-- bar size	12.7 mm
-- pitch	40 mm
Secondary Digger Chain:	
-- type	dual rubber covered chain
-- number of links	112
-- length	4480 mm
-- bar size	11.1 mm
-- pitch	40 mm
-- number of flights	14 rubber
Deviner Chain:	
-- type	single rubber covered chain
-- number ct links	62
-- length	7940 mm
-- bar size	159 mm
-- pitch	128 mm
Rear Cross Conveyor:	
-- type	rubber covered chain
-- number of links	94
-- length	3760 mm
-- bar size	11.1 mm
-- pitch	40 mm
Elevating Conveyor:	
-- type	rubber covered chain
-- number of links	176
-- length	7040 mm
-- bar size	11.1 mm
-- pitch	40 mm
-- number of flights	17 rubber
Clod Roller Table:	
-- type	rubber covered rollers
-- number of rollers	16
-- roller diameter	73 mm
-- pitch	115 mm
-- pitch gap	42 mm
Picking Table/Delivery Boom:	
-- type	rubber covered chain
-- number of links	327
-- length	12,950 mm
-- bar size	11.1 mm
-- pitch	40 mm
-- number of flights	35 rubber
Powered Trash Roller:	
-- length	810 mm
-- diameter	100 mm
Stripper Roller:	
-- length	1400 mm
-- diameter	255 mm
Number of Chain Drives:	14
Number of Gear Boxes:	4
Number of Sealed Bearings:	40
Number of Pressure Grease Fittings:	23
Clutches:	
-- slip clutches	2
-- torque hinders	2
Tires:	2, 9.00 x 24, 8-ply
Overall Dimensions:	
-- wheel tread	2110 mm
-- transport height	4320 mm
-- transport length	8230 mm
-- transport width	5360 mm
-- field height	2540 mm
-- field length	8230 mm
-- field width	6705 mm
-- ground clearance	510 mm
Turning Radius:	
-- without steering	10,360 mm
-- with power steering	6100 mm
Weight: (unloaded)	
-- right wheel	2078 kg
-- left wheel	2424 kg
-- hitch	1300 kg
TOTAL	5802 kg
Optional Equipment:	
-- power steering	
-- power trash roller	
-- stopper roller	
-- long clod roller table	

APPENDIX II
MACHINE RATINGS

The following rating scale is used in PAMI Evaluation Reports

(a) excellent	(d) fair
(b) very good	(e) poor
(c good	(f) unsatisfactory

ALBERTA FARM MACHINERY RESEARCH CENTRE

3000 College Drive South
Lethbridge, Alberta, Canada T1K 1L6
Telephone: (403) 329-1212
FAX: (403) 329-5562
http://www.agric.gov.ab.ca/navigation/engineering/afmrc/index.html

Prairie Agricultural Machinery Institute
Head Office: P.O. Box 1900, Humboldt, Saskatchewan, Canada S0K 2A0
Telephone: (306) 682-2555

Test Stations:
P.O. Box 1060
Portage la Prairie, Manitoba, Canada R1N 3C5
Telephone: (204) 239-5445
Fax: (204) 239-7124

P.O. Box 1150
Humboldt, Saskatchewan, Canada S0K 2A0
Telephone: (306) 682-5033
Fax: (306) 682-5080