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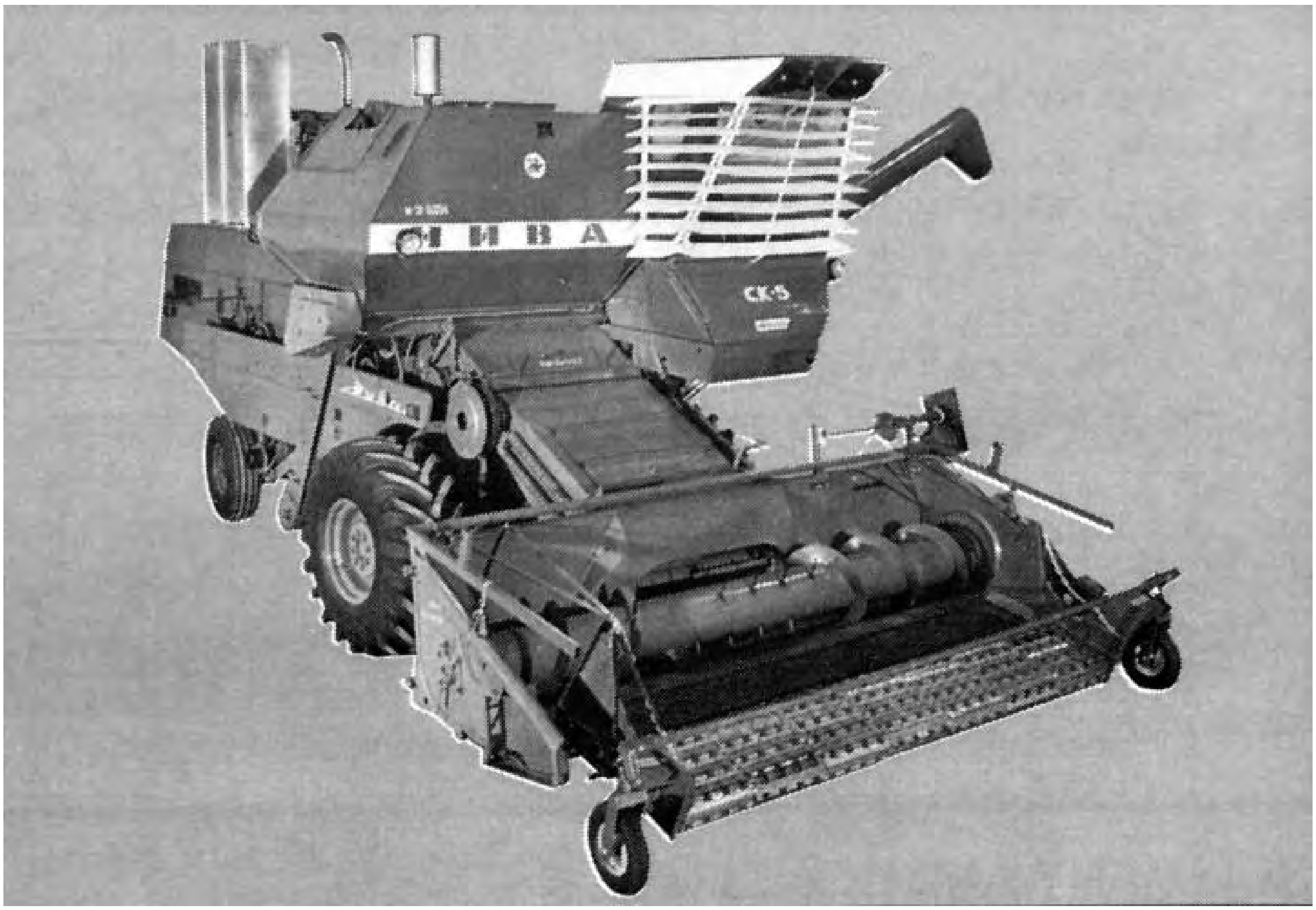


Belarus Niva SK-5 Self-Propelled Combine

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

BELARUS NIVA SK-5 SELF-PROPELLED COMBINE

MANUFACTURER:
Tractoroexport
Rostselmash
Rostov-on-Don, U.S.S.R.

DISTRIBUTOR:
Belarus Equipment of Canada Ltd.
1739 Victoria East
Regina, Saskatchewan
S4P 0P9

RETAIL PRICE:
$27,926.24 (July, 1977, f.o.b. Regina with 4420 mm (14.5 ft) table, 3200 mm (126 in) Melroe pickup, grain loss monitor, automatic feed control, six-bat pickup reel, cutter bar, metric tools and spare parts kit.

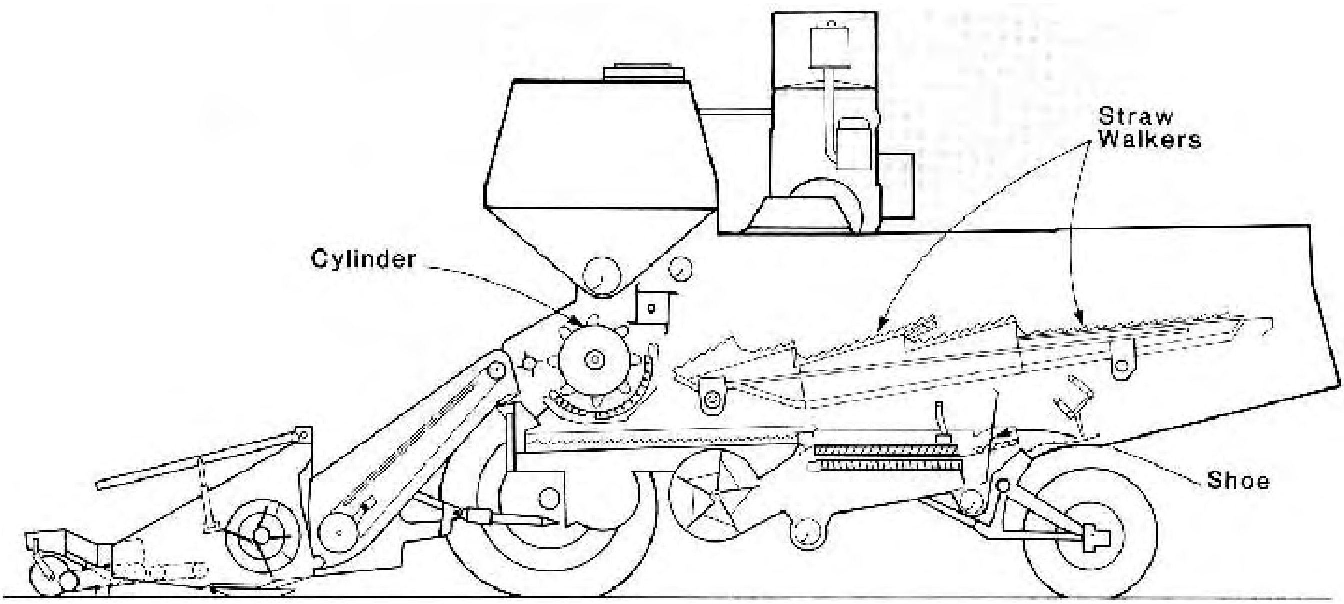


FIGURE 1. Schematic View of the Belarus Niva SK-5.

SUMMARY AND CONCLUSIONS

Functional performance of the Belarus Niva SK-5 self-propelled combine, was very good in dry grain and oilseed crops. Functional performance was very good to good in tough and damp crops.

The MOG feedrate (straw and chaff feedrate) at 3% total grain loss varied from 8.95 t/h (329 lb/min) in 2.76 t/ha (41 bu/ac) Neepawa wheat to 7.3 t/h (268 lb/min) in 3.48 t/ha (65 bu/ac) Bonanza Barley. The capacity of the Niva SK-5 was greater than the capacity of the PAMI reference combine for a similar total loss. Straw walker loss limited the capacity of the NIVA SK-5 in most crops. A reduction in grain loss over the straw walkers would have permitted higher combining rates. Cylinder and shoe losses usually were insignificant.

The engine had ample power for normal crops but operated near its limit when combining heavy, damp crops in soft, hilly fields. It would probably be underpowered if using a straw chopper in heavy damp crops. Fuel consumption varied from 14 to 18 L/h (3 to 4 Imp. gal/h).

Air entrainment problems with the fuel system occurred intermittently during the test resulting in poor starting, occasional loss of power and rough idling. The radiator screen did not effectively prevent radiator plugging while the engine air intake pre-cleaner was ineffective leading to rapid plugging of the filter elements. At temperatures below +5° C, ether was needed to start the cold engine.

After modifications, performance of the automatic feed control was very good in uniformly varying windrows and the control effectively maintained losses near a desired level. The automatic feed control could not be used in bunchy windrows and had to be switched to manual mode. The factory installed grain loss monitor was very easy to set and was reasonably accurate.

The steering system and individual wheel brakes were unsatisfactory since it was impossible to turn most corners in a windrowed field without stopping and reversing to negotiate the turn. Instrument and control lever layout at the operator's station was poor. Many controls were irresponsive and inconveniently placed. The cab was very dusty due to ineffective pressurization. Sound level at the operator's ear was about 90 decibels (A scale).

Header visibility was good during the daytime, but was poor at night because of poor long range lighting and reflections from the windshield louvers. Grain tank visibility was very good.

Road transport was tedious due to difficult handling and a low maximum speed of 20.1 km/h (12.4 mph). Right visibility was severely restricted by the grain tank requiring extra caution at road intersections.

Grain tank capacity of 2.1 t (77 bu) was too small and did not match the threshing and separating capacity at the NIVA SK-5. The unloading auger clutch was unsuitable for unloading on-the-go.

The NIVA SK-5 was easy to adjust for specific field conditions. Ease of adjustment would have been improved if return tailings could have been inspected. Ease of servicing was good.

The cylinder, table auger and feeder all were positive and aggressive. Plugging was infrequent, even in damp conditions. If plugging occurred, unplugging was relatively easy and convenient.

The stone trap was not completely effective and permitted a number of stones to enter the cylinder. The stone trap was inconvenient to clean.

Once properly adjusted, the pickup had excellent feeding characteristics, delivering the crop beneath the table auger. The pickup drive was unsatisfactory as delivered. After modification, performance of the pickup drive was good in dry crops and fair in damp crops.

No serious safety hazards were encountered when operated according to the manufacturer's recommended procedures.

Although the operator's manuals provided much information,

including a parts list, they were very wordy and difficult to understand and did not include some necessary information.

A considerable number of minor but aggravating durability problems occurred and several field modifications had to be performed resulting in many hours of down time. Most problems stemmed from improper pre-delivery by the local distributor. In addition, distributor service personnel were unfamiliar with combine maintenance, servicing and adjustment and were unable to correct some problems.

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Modifying the steering and individual wheel brakes to allow non stop picking of windrows around 90° corners.
2. Increasing the grain tank capacity to match threshing and separating capacity.
3. Modifying the grain tank unloading clutch to permit unloading on-the-go.
4. Increasing header lift speed and maximum header lift height.
5. Providing a safe and easy method for sampling return railings, preferably from the operator’s seat.
6. Modifying the variable speed traction drive belt tightener assembly or modifying the belt tightening instructions in the operator’s manual to prevent pivot clevis deformation when tightening the traction drive belts.
7. Checking assembly procedures to ensure proper main hydraulic pump clutch adjustment and assembly.
8. Modifying procedures to prevent entrance of foreign material into the hydraulic system during factory assembly as well as flushing of hydraulic systems, on combines already in stock, before delivery.
9. Improving the quality of the clean grain sieve to ensure uniform closing of all louvers.
10. Providing a straw chopper and a straw spreader as available options.
11. Modifying the actuating cable on the automatic feed control to make the control operational and, in addition, initiating proper pre-delivery procedures on the control system and instructing distributor service personnel on its correct operation and adjustment.
12. Supplying an elevated cyclone pre-cleaner for the engine air intake as standard equipment.
13. Modifying the radiator air intake screen to improve radiator cooling efficiency.
14. Providing a lock on the seat backrest to improve operator safety.
15. Modifying the windshield louvers so they can readily be swung out of the way for night operation and for windshield cleaning.
16. Modifying the lighting system to provide better long range lighting in front of the combine for night operation.
17. Modifying the cab pressurization system to reduce dust accumulation in the cab.
18. Installing the main power switch in the operator’s cab.
19. Modifying the speedometer to eliminate its erratic and intermittent performance.
20. Modifying the hydraulic control lever assemblies for header lift and pickup speed to reduce rapid linkage wear and to increase ease of operation.
21. Repositioning the ground speed and header lift control levers to one side of the steering column to increase ease of operation.
22. Modifications to eliminate air entrainment problems in the engine fuel system and instructing distributor service personnel on proper fuel system servicing procedures.
23. Modifications to prevent premature header drive belt failure.
24. Modifying the pickup drive assembly to eliminate belt slippage and to eliminate creeping of the pickup speed control. In addition, improving procedures at the distributor level to ensure that the pickup is properly assembled and supplied with the proper drive sprockets at delivery.
25. Modifying the stone trap to increase its effectiveness and to improve ease of stone removal.
26. Improving the ease of removal of the chaffer and clean grain sieves and including removal instructions in the operator’s manual.
27. Providing an extension on the grease fitting for the inboard upper tailings cross auger bearing to improve ease and safety of lubrication.
28. Improving overall pre-delivery servicing and adjustment of the combine.
29. Revising the operator’s manual to improve clarity, and to include missing information such as loss monitor adjustment procedure, a complete lubrication schedule, instructions for removing the chaffer and sieve and instructions for properly adjusting the variable speed traction drive belts.

Chief Engineer E.O. Nyborg
Senior Engineer - L.G. Smith
Project Engineer- P.D. Wrubleski

THE MANUFACTURER STATES THAT

With regard to recommendation number:

1. Rear tread width has been increased and steering geometry modified to allow sharper turns.
2. A 4.5 m³ (150 bu) capacity grain tank will be installed on the new model NIVA SK-5.
3. The existing clutch is designed to permit unloading on-the-go. No problems have been encountered to date.
4. The header lift is designed to travel from ground level to full height in 4 seconds. Low lift rata on the model tested may have been caused by problems outlined in RECOMMENDATION 8. Modification to header lift height is under consideration.
5. Providing for sampling of return tailings from the operator’s platform would require major design changes in the combine. The operator is warned of overloading by light and by horn.
6. A hydraulic cylinder automatically controls belt tension and the tightener frame has been strengthened on the new model NIVA SK-5.
7. No problems of this nature have been experienced with other models of the NIVA SK-5. The shifter fork may have been improperly engaged. A decal will be added to advise of proper operating procedure.
8. A magnetic method of cleaning the hydraulic pipes and flushing the hydraulic system has been incorporated at the factory.
9. This recommendation is being considered.
10. A straw chopper is now available as an option for the Niva SK-5.
11. A modified automatic feedrate control has been incorporated in the new model NIVA SK-5.
12. A pre-cleaner bag, normally supplied as standard equipment should have been supplied and installed on the NIVA SK-5.
13. A new design of radiator air intake is used on the current model NIVA SK-5.
14. A more comfortable operator’s seat with locking back rest will be installed on the new model NIVA SK-5.
15. New louvers with wider spacing permit better visibility for night operation and improved access for windshield cleaning.
16. The lighting system will be modified on the new model NIVA SK-5. Additional lights are presently available as an option.
17. A new design of cab with better pressurization system will be installed on the new model NIVA SK-5.
18. The main power switch will be installed in the operator’s cab.
19. Lubrication of the speedometer drive has been incorporated into pre-delivery servicing to eliminate this problem.
20. Modified hydraulic control lever assemblies for all controls will be installed on new model NIVA SK-5.
21. The ground speed and header lift control levers will be repositioned on the new model NIVA SK-5.
22. This problem is under investigation.
23. It is recommended that the drive be engaged only at low engine speed. Provision of higher quality belts is being investigated.
24. The pickup and drive assembly was supplied by Melroe Division, Clark Equipment. A factory built pickup drive assembly which eliminates belt slippage is now available. The creeping of the pickup speed control was probably due to a

damaged O-ring in the piston.

25. The stone trap will be modified on new model Niva SK-5.
26. The straw buncher feed finger assembly will be removed from combines sold in Western Canada and replaced with a deflector shield over the rear axle. In addition, instructions on removal of sieves will be more explicit.
27. The inboard bearing on the cross auger has been replaced with a sealed bearing. In addition, all other bearings on the combine with the exception of the two main cylinder bearings are sealed units.
28. Pre-delivery instructions at the branch level will be more explicit with complete running-in of all units before delivery.
29. New instruction manuals will be supplied complete with a lubrication chart and information on all necessary adjustments.

GENERAL DESCRIPTION

The Belarus Niva SK-5 (FIGURE 1) is self-propelled and powered with a 82 kW (110 hp) turbocharged four cylinder Diesel engine. The traction drive is through a three speed transmission with a single plate dry clutch and variable speed belt. The Niva SK-5 is equipped with hydraulic wheel brakes, power steering, a louvered cab, an automatic feed controller and a loss monitor. A spare parts kit and a set of metric tools are included.

The Niva SK-5 has a 4420 mm (14.5 ft) floating header and is supplied with a 3200 mm (126 in) Melroe 351 pickup. Neither a straw spreader nor a straw chopper are available.

The separator drive is lever controlled through a single-plate dry clutch, while the header drive is lever controlled through an over-centre belt tightener. The grain tank unloading auger is engaged through a dog clutch and can be operated only when the separator is running.

Hydraulic levers control the ground speed, header height, pickup or reel speed, reel height, grain tank vibrator for tough grain, and the radiator chaff deflector. Both concave clearance and cylinder speed can be adjusted on-the-go from the operator's platform. Fan speed is adjusted by a hand wheel controlling a variable speed belt drive, while the chaffer and Sieve are adjusted with hand wheels on the side of the combine. There is no provision to safely and quickly sample the return tailings.

Complete specifications are given in APPENDIX I.

SCOPE OF TEST

The Belarus Niva SK-5 was operated in a variety of Saskatchewan and Alberta crops (TABLES 1 AND 2) for 169 hours while harvesting about 354 ha (873 ac). It was evaluated for ease of operation, ease of adjustment, rate of work, grain loss characteristics, operator safety, and suitability of the operator's manual. Throughout the test, comparisons were made to the PAMI reference combine.

TABLE 1. Operating Conditions

		Average Yield		Swath Width			Field Area	
Crop	Variety	t/ha	bu/ac	m	ft	Hours	ha	ac
Wheat	Neepawa	2.8	41	4.9-6.1	16-20	75.0	164	404
Barley	Betzes	2.5	47	4.9-5.5	16-18	12.0	17	42
Barley	Bonanza	2.4	45	4.6-7.3	15-24	38.5	73	180
Oats	Harmon	3.4	88	4.6-6.1	15-20	13.0	19	47
Flax	Linott	1.3	20	4.9	16	10.5	30	74
Rapeseed	Midas	1.2	21	4.6-4.9	15-16	20.0	51	126
Total						169	354	873

TABLE 2. Operation in Stony Fields

		Field Area	
Field Conditions	Hours	ha	ac
Stone Free	45	83	204
Occasional Stones	63	138	341
Moderately Stony	34	70	172
Very Stony	27	63	156
Total	169	354	873

RESULTS AND DISCUSSION

EASE OF OPERATION

Operator Location: The Niva SK-5 was equipped with an operator's cab as standard equipment. The cab was positioned left of the grain tank giving good visibility to the rear, left, and front. Visibility to the right was completely obstructed by the grain tank, requiring extra care during highway transport or when manoeuvring in confined areas. The grain level could be viewed through a small window but grain and return tailings could not be sampled from the operator's seat.

The operator's seat was fairly comfortable and had an ample range of adjustment, however, seat adjustments were inconvenient. The folding backrest was hazardous. Most operators, when stepping down into the cab, would lean on the backrest for support and would fall forward as the backrest folded (FIGURE 2). The cab was high enough to permit standing operation.

FIGURE 2. Folding Seat Backrest.

All windows were shaded with external metal louvers. The louvers appreciably reduced cab temperature by preventing direct sunlight from entering. Although visibility was good for normal combining, the louvers severely restricted upward visibility for passing under telephone or power lines. Night visibility was poor due to inadequate long range front lighting and louver reflections on the windshield. Cleaning windows under the louvers was very difficult as they were bolted in place and could not be swung outward.

When the louvers were removed, night visibility was good, but the cab became extremely hot and uncomfortable during sunny days. It is recommended that the manufacturer consider hinged louvers that can easily be swung out of the way for night operation and for window cleaning.

The cab was very dusty. It was pressurized with two fans but they were ineffective in keeping dust out of the cab. The foam filter on the fan outlet severely restricted airflow. An additional propeller fan was provided for air circulation within the cab or windshield defrosting. Although this fan could be used for cooling the operator's face, the dust moved by the fan caused eye irritation.

Total noise at operator ear level was 90 decibels (A scale) with all doors and windows closed while operating at rated capacity in wheat. This noise level equals current operator exposure recommendations[1] for eight hours per day. It is recommended that the operator wear suitable ear protection if operating for more than eight hours per day.

Controls: The control arrangement for the Niva SK-5 is shown in FIGURE 3. The hydraulic control levers for header height, reel

[1] "Occupational Safety and Health Standards ", Fed. Regist. 36(105), Pt. II (May 29, 1971)

height, pickup or reel speed, radiator chaff deflector and grain tank vibrator were located in a cluster to the right of the operator. Arrangement of these controls was confusing, the controls were quite irresponsive and the mechanical linkages wore rapidly during use. The header lift was slow, especially with warm hydraulic fluid, often necessitating stopping when crossing gullies or washouts, to prevent the header from striking the ground.

FIGURE 3. Control Layout on the Niva SK-5.

The variable speed traction drive control was located to the left of the operator. Since the traction drive and header height controls were on opposite sides of the cab, the operator constantly had to change hands on the steering wheel when combining bunchy non-uniform windrows. It is recommended that the ground speed and header height controls be repositioned together, close to the steering wheel on the same side of the steering column.

Although the concave adjusting lever and separator drive lever were conveniently positioned, when the concave was closed interference occurred among the concave lever, separator drive lever and header height control lever (FIGURE 4).

FIGURE 4. Interference Among Control Levers.

The Niva SK-5 was equipped with an automatic feed control (FIGURE 5) and a loss monitor as standard equipment. The feed control sensed the amount of straw entering the feeder and automatically adjusted the forward speed according to the amount of straw in the feeder. Two levers, to the left of the operator were used to set the feed control. A two position lever set the combine in either the manual or automatic feeding mode, while the second lever set the feed control at the desired feedrate. The desired feedrate was determined by referring to the loss monitor output. Once the control was properly set, it very effectively held the combine below a desired loss level by automatically varying the forward speed to maintain a uniform feedrate. Feedrate control was very good in uniformly varying windrows. The automatic feed control could not be used in very bunchy windrows and also had to be set to manual before turning corners. In very bunchy windrows, the automatic feed control could not respond fast enough.

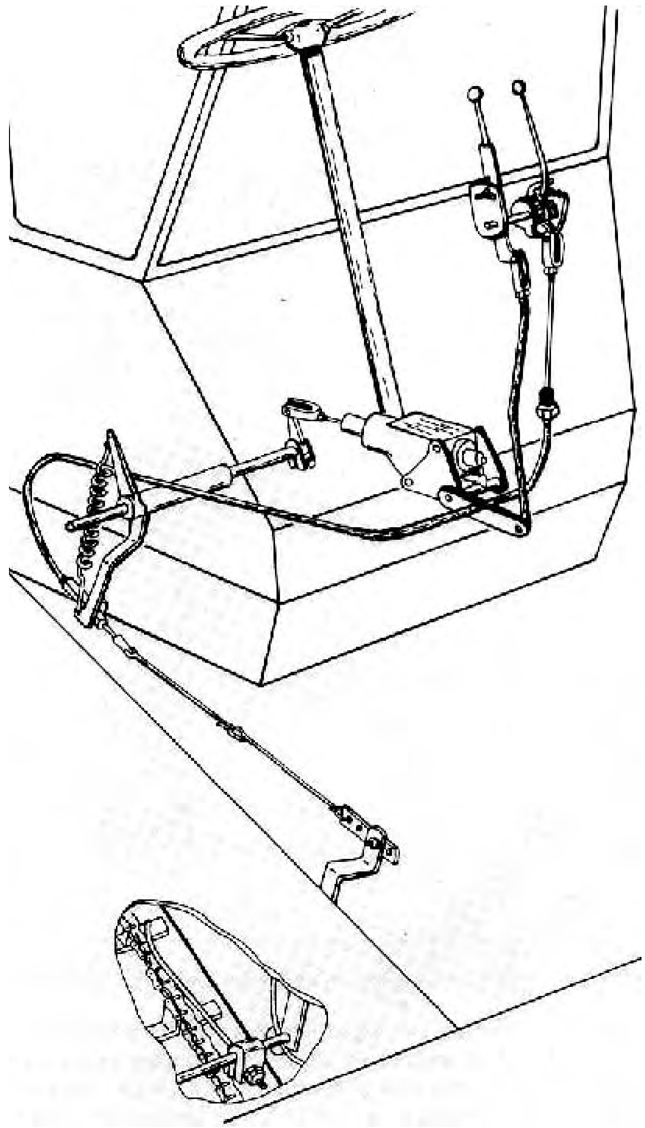


FIGURE 5. Automatic Feed Control on Niva SK-5.

Steering: Steering and maneuverability of the Niva SK-5 were unsatisfactory. Although it was equipped with power steering, the steering was hard and irresponsive. The turning radius was 6910 mm (23 ft) to the right and 9800 mm (32 ft) to the left. It was impossible to pick windrows around 90 degree corners (FIGURE 6) without stopping and backing up during the turn. Gears were difficult to shift and the combine had to come to a complete stop for shifting. The individual wheel brakes had to be pumped each time they were used and were ineffective in reducing the turning radius. The steering and braking system must be modified before the Niva SK-5 is acceptable for Western Canadian conditions.

Instruments: The instrument console (FIGURE 7) included gauges for engine oil pressure, battery charging rate, coolant temperature, ground speed, and cylinder speed. Indicator lights were provided for engine oil temperature, grain tank level return and clean grain elevator slip clutches, turn signals, parking brake, and for the main power switch. The main power switch was inconveniently located outside the cab on the side of the combine and could only be conveniently reached from the ground. The main power switch had to be turned off whenever the engine was not running to prevent battery discharge. The electrical system circuit breaker was also inconveniently located inside the battery box.

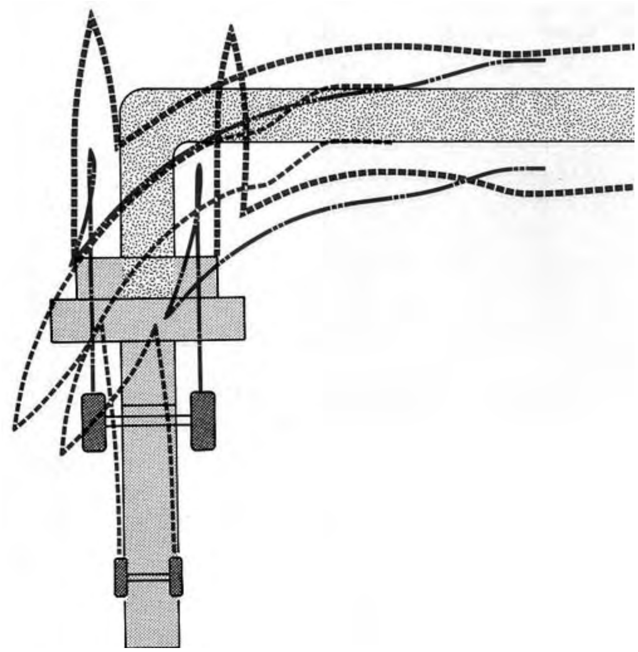


FIGURE 6. Schematic Illustration of Manoeuvring Required to Pick a Windrow Around a 90° Corner.

FIGURE 7. Instrument Console on Niva SK-5.

The speedometer was driven from the transmission input shaft and had a scale for each gear. Its operation was erratic and intermittent throughout the test.

The grain loss monitor dial was conveniently located on the steering column. The monitor was easy to calibrate and adjust. It sampled the amount of clean grain passing through the shoe as well as walker and shoe losses and gave a readout in percent loss. The percent-loss-readout was more meaningful than the non-calibrated readouts on some loss monitors, giving the operator a better appreciation of combine performance in varying crop conditions.

Lights: The Niva SK-5 had adequate lighting for the grain tank, the unloading auger, and the rear of the combine. Lighting at the header was very good but long range lighting in front of the combine was poor.

Engine: The engine had ample power reserve for normal combining but operated near its power limit when combining damp crops on soft, hilly fields. The engine had sufficient power reserve for the addition of a straw chopper in normal dry crops but probably would be underpowered with a straw chopper in heavy damp crops. Average fuel consumption varied from 14 to 18 L/h (3 to 4 gal/h). The engine was very easy to service and was accessible from all sides.

The engine radiator screen plugged quickly when combining dusty crops. The hydraulic diverters for chaff removal usually had to be operated several times for each hopper of grain. Although the engine temperature warning light signalled the operator that cleaning was necessary, a rotating inlet screen for automatic chaff removal, as is commonly used on most combines, would be more convenient. The radiator screen also was ineffective in preventing radiator plugging and occasional cleaning, especially between the radiator and oil cooler, was required.

The engine air intake used a screen pre-cleaner and two dry filters. The filters were very effective in keeping dust out of the engine but the outer filter plugged quickly in dusty conditions and needed daily cleaning. A centrifugal bowl pre-cleaner in place of the screen pre-cleaner is recommended to increase filter life and reduce filter servicing.

The engine was equipped with a 24V electric starter. It had a decompression lever, hand primer pump and a starter button on the engine for cold starting, as well as a starter button on the instrument console for normal use. If night temperature dropped below +5°C, ether was needed to start the cold engine. As the engine was not equipped with an automatic ether starting aid, ether had to be hand fed through the engine air intake. At higher ambient temperatures, the cold engine started easily using the hand primer pump and decompression lever.

During the last part of the test, the engine fuel system was plagued with problems of air entrainment resulting in loss of power, poor starting and rough idling. Although the problem appeared to be of minor nature, caused by fuel line air leaks, probably at the hand primer pump, local manufacturer service personnel were unable to correct the problem.

Engine oil consumption was about 0.9 L (1 quart) every 10 hours when new. Oil consumption gradually decreased during the test as the engine wore in.

Stability: The Niva SK-5 was very stable, even with a full grain tank. The centre of gravity with a three-quarters full grain tank was 1580 mm (62 in) above ground, 450 mm (18 in) behind the drive wheels and 30 mm (1 in) to the left of the combine centre line. Normal care had to be used when turning corners on steep hillsides.

Grain Tank: The grain tank held 2.1 t (77 bu) of wheat. Unloading a full hopper of dry wheat took 75 seconds. The grain tank was covered, with access through a small door on top. A level indicator light signalled the operator when the grain tank was full and a flashing light and horn on the elevator slip clutch signalled the operator if overfilling was attempted. The grain tank was much too small. To match the threshing and separating capacity of the Niva SK-5, the grain tank should hold at least 4 t (150 bu). The grain tank cover made tank access and sample inspection difficult and prevented the possibility of attaching extensions to increase tank capacity. The grain tank cover was removed and special tank extensions were fabricated in an attempt to increase tank capacity. The grain elevator, however, did not have enough capacity to fill the tank beyond its original level, except in oats. If the separator drive was stopped with a full hopper of flax, flax ran down the clean grain elevator, completely plugging it, requiring hand cleaning before the separator could be started.

The unloading auger drive was through a jaw clutch and operated only when the separator drive was engaged. Since the clutch was positive, it subjected the auger drive to excessive impact loads unless engine speed was reduced before engaging the auger. Although auger height and reach were ample for easy unloading on-the-go, the auger clutch made on-the-go unloading impractical. The hydraulic vibrator on the grain tank floor was very effective in emptying the tank when combining damp grain, however, the unloading auger occasionally would not start when the tank was filled with tough barley. The unloading auger folded manually for transport. One man could easily fold the auger in less than a minute.

The grain tank, grain elevator and unloading auger drive all require modification before the Niva SK-5 is suitable for Western Canadian conditions.

Plugging: The table auger and feeder were very aggressive. When properly adjusted, table auger plugging seldom occurred, even in damp crops. Occasional plugging of the table auger occurred in tough bunchy Midas rapeseed and in damp heavy windrows of Bonanza and Betzes barley. Table auger unplugging was made easy by using the supplied bar and rocking hub on the upper feeder shaft. The feeder conveyor never plugged during the test.

The cylinder was very aggressive and positive. Plugging and backfeeding seldom occurred, even in damp and wet windrows. If the cylinder plugged, it could usually be unplugged from the operator's seat, by lowering the concave. Cylinder access was convenient and there was ample room to use a breaker bar through the cylinder bars, if severe plugging should occur. It was important to keep the thresher clutch and all drive belts in proper adjustment when combining tough crops.

A s with most combines, dust and chaff collected inside the cylinder rasp bars, causing cylinder imbalance. The inside of the rasp bars occasionally had to be cleaned to prevent cylinder vibration.

Stone Trap: The Niva SK-5 was equipped with a stone trap in front of the cylinder. Although the trap caught many stones, roots or stones could occasionally be heard passing through the cylinder and one stone bent the front concave bar and broke one of the front concave hanger bolts. As with most combines, if a large stone was inadvertently picked, it could damage the table auger or feeder before being stopped by the stone trap.

Cleaning the stone trap was inconvenient. The header had to be raised and an access door under the cylinder removed by hand. Stones could be removed through three 102 by 248 mm (4 by 9.8 in) openings (FIGURE 8). Larger stones, which could not pass through these openings, had to be maneuvered into the feeder housing and removed by turning the feeder backward.

FIGURE 8. Stone Trap Access on the Niva SK-5.

Pickup: The Niva SK-5 was equipped with a 3200 mm (126 in) Melroe model 351 pickup. The pickup was installed by the local distributor before combine delivery. Several problems resulted with the pickup due to improper installation. Improper drive sprockets were supplied, the windguard was improperly assembled and severe drive belt slippage occurred. The pickup was powered from the reel drive (FIGURE 9). The reel drive was not designed for the type of load imposed by a pickup. As a result, the reel pivot pipe flexed causing the drive belt to loosen and slip under load. In addition, the variable speed reel drive, which was also used as a pickup drive, constantly crept to slow-speed position during operation because the control ram worked loose in its support clamp.

The reel support pipe was braced to eliminate flexing, different drive sprockets were installed to obtain proper pickup speed and the windguard was removed and properly assembled. This corrected most of the drive problems, however, creeping of the variable speed drive sheave to slow-position, accompanied by variable speed belt slippage occurred frequently during the test although the support clamp was repeatedly tightened. The pickup drive requires modification before it is suitable.

In spite of drive problems, the pickup had excellent feeding characteristics, delivering the crop beneath the table auger in all conditions. In bunchy Midas rapeseed, the windguard had to be removed to eliminate plugging between the windguard and pickup draper. Some plugging occurred between the rear pickup roller and the front draper roller in damp Bonanza and Betzes barley.

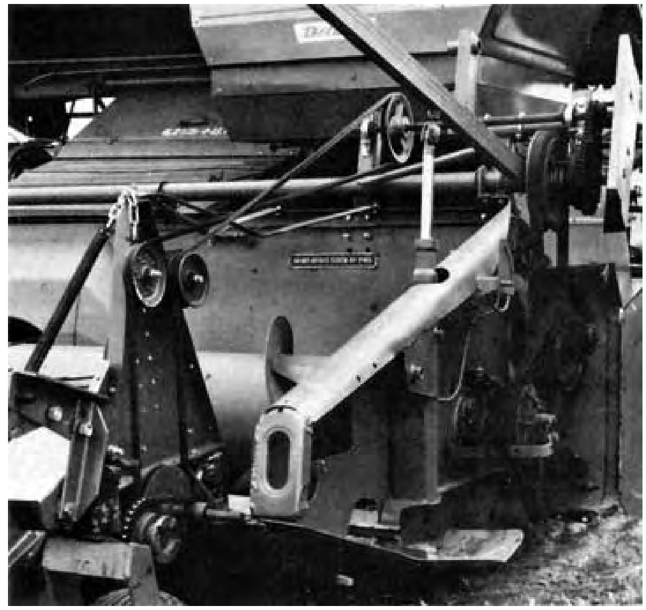


FIGURE 9. Drive Assembly for the Melroe Pickup on the Niva SK-5.

Machine Cleaning: When operating in tough or damp crops, the grain pan steps occasionally built up with an accumulation of dirt. The grain pan steps could be cleaned through side access doors with a cleaning poker supplied with the combine.

As with most combines, completely cleaning the Niva SK-5, for combining seed grain was a laborious, time-consuming job. The chaffer and sieve were very difficult to remove. Removal and replacement for cleaning took about two hours. The grain tank was difficult to clean due to the small access port and many obstructions.

Lubrication: The Niva SK-5 had 109 pressure grease fittings. The lubrication schedule outlined in the operator's manual was confusing. Thirty-three fittings were not included in the lubrication chart. Of the remainder, two required greasing every 10 hours, 21 required greasing every 60 hours and 35 required greasing every 240 hours. Three fittings were difficult to reach; the remainder were quite accessible.

Engine and hydraulic oil levels required daily checking while the common transfer case for the transmission, differential and final drives should be checked every 60 hours. The engine was equipped with a spinning disk mechanical oil filter. It had to be removed and cleaned every 240 hours when the engine oil was changed.

EASE OF ADJUSTMENT

Field Adjustments: The Niva SK-5 was easy to adjust and could be quickly set for a crop by one person. Since return tailings could not be inspected, the operator did not have a complete feel of the effect of settings on performance. Both cylinder speed and concave clearance could be adjusted from the operator's seat, however, if return tailings could have been inspected, the need for changing settings during the day would have been easier to detect.

Concave Adjustment: The Niva SK-5 had a two section concave (FIGURE 10). Both sections were reversible, permitting the concave to be turned around when worn. The concave was easily levelled and inspected through three inspection holes on each side of the combine. A set of feeler gauges for levelling was supplied. In closed position, the manufacturer recommended clearances of 2 mm (0.08 in) at the rear, 14 mm (0.55 in) at the centre and 18 mm (0.71 in) at the front. This minimum setting was suitable for all crops except flax. In flax, a minimum setting of 1 mm (0.04 in) rear, 13 mm (0.51 in) centre and 17 mm (0.67 in) front was found suitable. The concave adjusting lever, on the operator's platform, was convenient to use and had an ample range for all crops. In wide open position, clearances were 42 mm (1.65 in) rear, 46 mm (1.81 in) centre and 48 mm (1.89 in) front. Suitable concave settings were 4 mm (0.16 in) rear, 16 mm (0.63 in) centre and 20 mm (0.79 in) front in dry wheat. In rapeseed suitable settings were 22 mm (0.87 in) rear, 33 mm (1.30 in) centre and 36 mm (1.42 in) front.

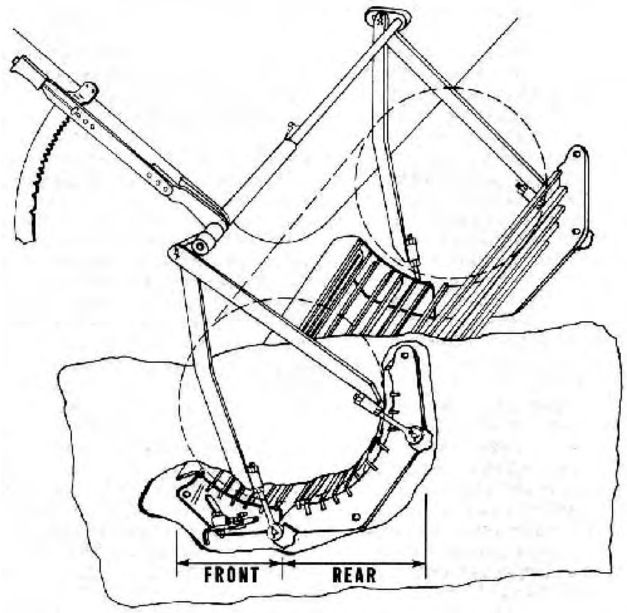


FIGURE 10. Concave on the Niva SK-5.

Filler bars were not required in any crop. When properly adjusted, average dockage from bolls, white caps, and chaff was about 0.5% in wheat and 0.75% in flax.

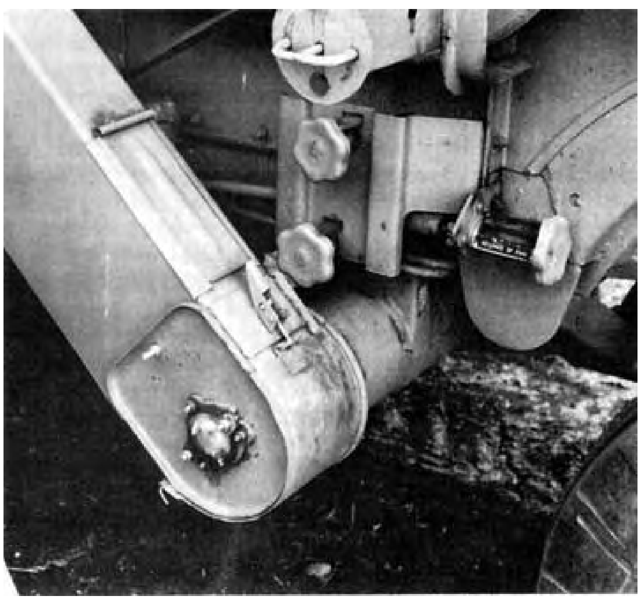


FIGURE 11. Shoe Adjustments on Niva SK-5.

Cylinder Adjustment: The cylinder was equipped with a variable speed drive, adjustable from the operator's seat, and a tachometer. The cylinder was also driven through a two-speed gearbox. This gave cylinder speeds from 325 to 600 rpm in low gear and 750 to 1360 rpm in high gear. Suitable cylinder speeds were about 800 rpm in flax, 900 rpm in dry wheat, 350 rpm in rapeseed, and 750 rpm in dry barley. Cylinder speeds from 600 to 750 rpm were not available. These speeds were not required during the test, however, they may be required for certain crops. Typical grain crackage varied from 0.5 to 1.5% when properly adjusted. The cylinder rasp bars were in good condition at the end of the test, showing negligible wear. The cylinder stripper consisted of 3 mm (0.125 in) thick belting attached to a metal plate. Although the belting was worn requiring replacement at the end of the test, backfeeding never was a problem.

Shoe Adjustments: The chaffer, clean grain sieve and fan were convenient to adjust with calibrated handwheels at the rear of the combine (FIGURE 11).

Chaffer extension opening and slope had to be adjusted from the rear through a sliding gate at the end of the shoe. This adjustment was inconvenient due to shielding by the straw rake pan. Care had to be taken to ensure that the rear. gate was properly adjusted to prevent loss of cleaning air.

The shoe was easily adjusted and performed well in most crops, after some modifications. The clean grain sieve, as delivered, did not close uniformly (FIGURE 12) making it difficult to set the sieve. The sieve was removed and the individual louvers were bent so that the sieve opened and closed uniformly. After sieve modifications, the shoe performed well in all crops and was fairly easy to set. The shoe would have been much easier to set if return tailings could have been inspected. Total dockage in the grain tank, including cracks, whitecaps, and chaff, usually varied from 1 to 3% when properly adjusted.

As is common with most combines, the shoe was difficult to set in non-uniform crops of some varieties of rapeseed due to the large variation in seed size and amount of shoe load between heavy and light windrows. It was found best to set the shoe for optimum performance in the heavy windrow sections and to increase feedrate in light windrow sections to maintain a fairly uniform shoe load. The automatic, feed control was very useful in reducing shoe loss in one non-uniform field of Midas rapeseed by maintaining a relatively uniform shoe load.

In normal conditions, shoe plugging never occurred. In late fall combining in extremely wet conditions, the chaffer and sieve plugged with wet material and combining could not take place unless the temperature was well below freezing.

As is common with most combines, the windrow should be centered on the feeder housing. Feeding to one side caused non-uniform shoe loading with increased shoe losses. Similarly, as with most combines, shoe loss increased noticeably when combining on side slopes greater than 3°, due to non-uniform shoe loading.

Adjusting the Automatic Feed Control: When the combine was received, the automatic feed control (FIGURE 5) was not operational. The sensor fingers were loose and out of adjustment, several pivot points lacked lubrication and were "seized" with paint, while, the control cable was faulty. Local distributor personnel were unable to correct these problems. Although a new control cable was supplied, it was also faulty. A modified control cable was fabricated by PAMI and the control was modified and adjusted to make it operational. Once it had been modified and properly serviced, the feed control performed well. Adjustments were simple. The feed control was set from the operator's seat by referring to the loss monitor output. It is recommended that the manufacturer properly pre-deliver and service the combine so that the automatic feed control is operational at time of delivery. Distributor service personnel should be trained in its proper operation.

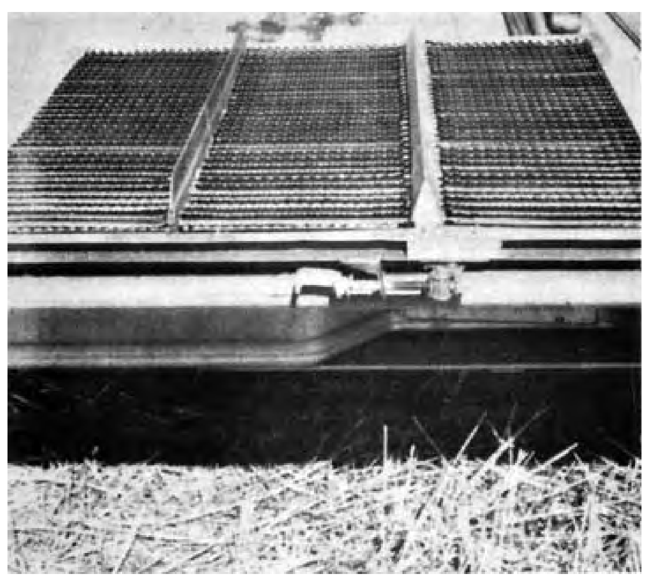


FIGURE 12. Uneven Closing of Louvers on Clean Grain Sieve.

Adjusting the Loss Monitor: The loss monitor was adjusted with a knob on the control box in the operator's cab. To set the monitor, the combine was operated at the maximum speed which gave negligible losses and the knob adjusted until the loss needle read zero. It was necessary to inspect losses on the ground behind the combine to determine the zero loss setting. The loss monitor had to be readjusted for every field. Once the operator became familiar with combine characteristics in various crops, adjusting the loss monitor was quite simple. When properly adjusted, any increase in losses above the selected zero loss level, was indicated on the meter as percent of total grain being harvested. Instructions for loss monitor adjustment were not included in the operator's manual.

Header Adjustments: The Niva SK-5 was equipped with a floating header. The floating mechanism allowed the header to follow ground contours, on skid shoes, independent of the combine wheels, and was designed for straight combining. The header floating mechanism was not evaluated since the combine was used only with a windrow pickup. When using a pickup the float linkage is locked.

The table could be removed from the feeder. Removal and installation took three men about 1.5 hours. The table and feeder housing could also be removed from the combine as a unit. Removal and replacement took two men about one-half hour.

RATE OF WORK

Average Workrates: TABLE 3 presents the average workrates for the Niva SK-5, at acceptable loss levels, in all crops harvested during the test. Average workrates are affected by crop conditions in a specific year and should not be used for comparing combines tested in different years. In some crops, workrates were reduced by bunchy and sunken windrows, muddy or rough ground, irregular shaped fields with many corners and driving the combine empty to unload grain at a central location. During the 1976 harvest, average workrates varied from 6.1 t/h (225 bu/h) in 2.8 t/ha (41 bu/ac) Neepawa Wheat to 3.0 t/h (132 bu/h) in 1.2 t/ha (21 bu/ac) Midas rapeseed.

TABLE 3. Average Workrates for the Niva SK-5

		Average Yield		Average Speed		Average Workrate			
Crop	Variety	t/ha	bu/ac	km/h	mph	ha/h	ac/h	t/h	bu/h
Wheat	Neepawa	2.8	41	6.2	3.3	2.2	5.5	6.1	225
Barley	Betzes	2.5	47	4.5	2.8	1.3	3.4	3.3	159
Barley	Bonanza	2.4	45	5.1	3.2	1.9	4.7	4.7	215
Oats	Harmon	3.4	88	4.3	2.7	1.4	3.4	4.7	304
Flax	Linott	1.3	20	8.0	5.0	2.9	7.0	3.8	140
Rapeseed	Midas	1.2	21	6.6	4.1	2.5	6.1	3.0	132

Maximum Feedrate: The workrates given in TABLE 3 represent average workrates at acceptable loss levels. The engine had ample power to achieve much higher workrates in nearly all crops. In most crops the maximum acceptable feedrate was limited by grain loss, while in light crops the maximum feedrate was limited by pickup performance. Maximum feedrate was limited by engine power only when combining wet heavy windrows in soft or hilly fields.

Capacity: Combine capacity is the maximum rate at which a combine can harvest a certain crop, at a specified total loss level, when adjusted for optimum performance. Many crop variables affect combine capacity. Crop type and variety, grain and straw moisture content, grain and straw yield and local climatic conditions during the growing season all affect the threshing and separating ability of a combine.

MOG Feedrate, MOG/G Ratio and Percent Loss: When determining combine capacity, combine performance and crop conditions must be expressed in a meaningful way. The loss characteristics of a combine in a certain crop depend mainly on two factors, the quantity of straw and chaff being processed and the quantity of grain being processed.

The weight of straw and chaff passing through a combine per unit time is called the MOG Feedrate. MOG is an abbreviation for "material-other-than-grain" and represents the weight of all plant material passing through the combine except for the grain or seed.

The weight of grain or seed passing through a combine per unit time is called the Grain Feedrate. The ratio of MOG Feedrate to Grain Feedrate, which is abbreviated as MOG/G gives an indication of how difficult a certain crop is to separate. For example, if a certain combine is used in two wheat fields of identical grain yield but one with long straw and one with short straw, the combine will have better separation ability in the short crop and will be able to operate faster. This crop variable is expressed with the MOG/G ratio when determining combine capacity. MOG/G ratios for prairie wheat crops vary from about 0.5 to 2.25.

Grain losses from a combine are of two main types, unthreshed grain still in the head and threshed grain or seed, which is discharged with the straw or chaff. Unthreshed grain is called cylinder loss. Free grain in the straw and chaff are called separator losses and consist of shoe loss and straw walker loss. Shoe and straw walker losses are very dependent upon MOG Feedrate and MOG/G ratio. Losses are expressed as a percent of total grain passing through the combine. Combine capacity is expressed as the maximum MOG Feedrate at which total grain loss (cylinder loss plus separator loss) is 3% of the total grain yield.

Capacity of the Niva SK-5: TABLE 4 presents capacity results for the Niva SK-5 in four different crops. MOG Feedrates for a 3% total grain loss varied from 9.7 t/h (357 lb/min) in a field of Neepawa wheat to 7.3 t/h (268 lb/min) in a field of Bonanza barley. In flax, the total loss level was only 1% at the maximum feedrate of 9.2 t/h (338 lb/min). In this crop, capacity was limited by pickup performance at higher speeds.

GRAIN LOSS CHARACTERISTICS

The grain loss characteristics for the Niva SK-5, in the four crops described in TABLE 4, are presented in FIGURES 13 to 16.

Walker Loss: As is common with most combines, walker loss was the most significant factor limiting capacity in all grain crops. Cylinder loss and shoe losses usually were insignificant in comparison to walker loss. A reduction in free grain loss over the straw walkers would have enabled much higher combining rates especially in difficult-to-separate crops such as barley.

Shoe Loss: Shoe loss rarely limited combine capacity although adjustment was critical in rapeseed and flax and high losses could occur with improper settings.

Cylinder Loss: Cylinder loss was low in all dry and well matured crops. Although loss increased slightly in tough and damp crops, it was always very acceptable. The good performance of the cylinder in damp crops was attributed to the large wrap of the concave (146°), which gave a large threshing area. A comparison of FIGURES 13 AND 14 illustrates the effect of improper cylinder adjustment. Both figures give results from 2.7 t/ha (40 bu/ac) fields of relatively hard-to-thresh Neepawa wheat. In FIGURE 13, the straw was tough and the grain moisture content was 14.7%. With proper adjustment, cylinder loss was about 0.5%. FIGURE 14 gives results for dry straw with grain moisture of 12.0% and the cylinder running too slow. In this case, cylinder loss varied from 0.5% to 2.5%. Increasing the cylinder speed slightly would probably have reduced cylinder loss to 0.5% in this crop.

Body Loss: Slight grain leakage occurred from the bottom and top inspection doors of the return elevator, and from several other locations, but was insignificant. Total grain leakage from the combine body, measured in a 1.3 t/ha (20 bu/ac) crop of Linott flax, was only 0.11% of yield.

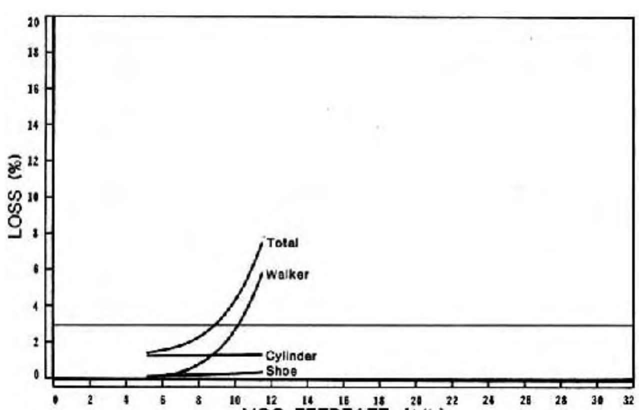


FIGURE 13. Grain Loss for the Niva SK-5 in Neepawa Wheat at 14.7% Grain Moisture Content.

TABLE 4. Capacity of the Niva SK-5 at a Total Grain Loss of 3% of Yield*

Crop Conditions									Capacity Results						
		Width of Cut		Crop Yield		Straw	Grain Moist.ure	MOG/	MOG Feedrate		Grain Feedrate		Ground Speed		
Crop	Variety	m	ft	t/ha	bu/ac	Condition	%	G	t/h	lb/min	t/h	bu/h	km/h	mph	Loss Curve
Wheat	Neepawa	5.5	18	2.76	41	dry to tough	14.7	1.31	8.95	329	6.83	251	4.5	2.8	Fig. 13
Wheat	Neepawa	5.5	18	2.72	40	dry	12.0	1.52	9.70	357	6.38	235	4.3	2.7	Fig. 14 & 17
Barley	Bonanza	7.3	24	3.48	65	dry to tough	14.6	0.96	7.30	268	7.45	342	2.9	1.8	Fig. 15 & 18
Flax	Linott	4.6	15	1.44	23	very dry	8.7	1.47	9.20	338	6.30	246	12.7	7.9	Fig. 16 & 19

*In flax, maximum total loss was only 1% of yield.

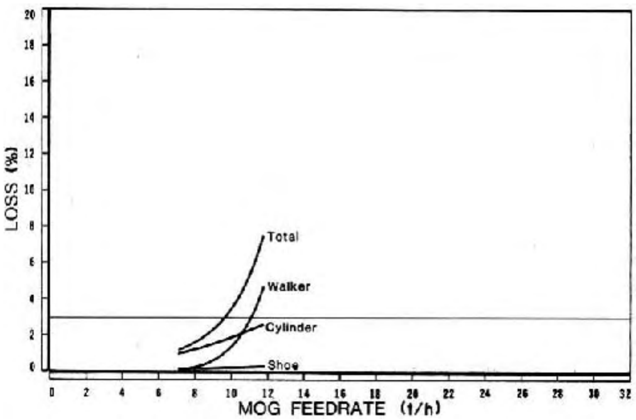


FIGURE 14. Grain Loss for the Niva SK-5 in Neepawa Wheat at 12.0% Grain Moisture Content.

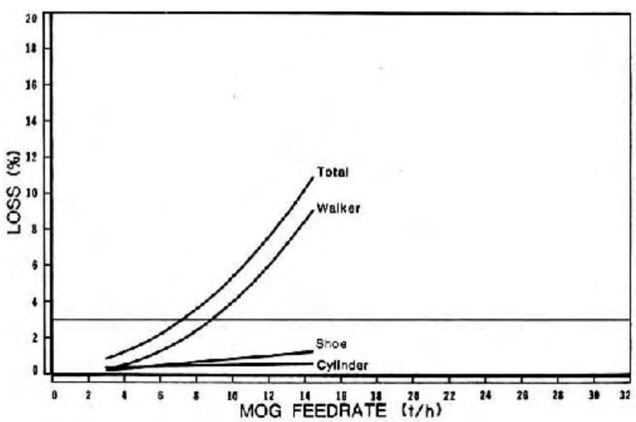


FIGURE 15. Grain Loss for the Niva SK-5 in Bonanza Barley.

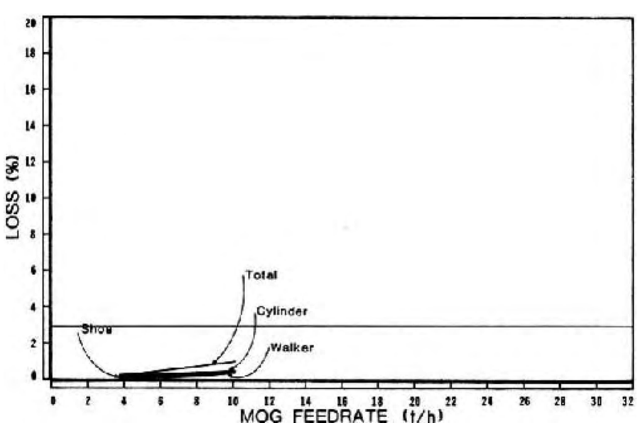


FIGURE 16. Grain Loss for the Niva SK-5 in Linott Flax.

Comparison to Reference Combine: Comparing the capacities of two combines is complex because crop and growing conditions influence combine performance with the result that slightly different capacity characteristics can be expected every year. As an aid in determining relative combine capacities, PAMI uses a reference combine. This combine is operated alongside test combines whenever capacity measurements are made. This permits the comparison of loss characteristics of every test combine to those of the reference combine, independent of crop conditions.

The reference combine used by PAMI is commonly accepted in the prairie provinces and is described in PAMI Evaluation Report E0576C.

FIGURES 17 to 19 compare the total grain losses of the Niva SK-5 and the PAMI reference combine in three of the crops described in TABLE 4. The shaded areas on the figures are the 95% confidence belts. If the shaded areas (confidence belts) overlap, the loss characteristic of the two combines are not significantly different whereas if the shaded areas do not overlap, the losses are significantly different. The capacity of the Niva SK-5 was greater than the capacity of the reference combine and the Niva SK-5 usually had lower grain losses than the reference combine when operating at the same feedrate.

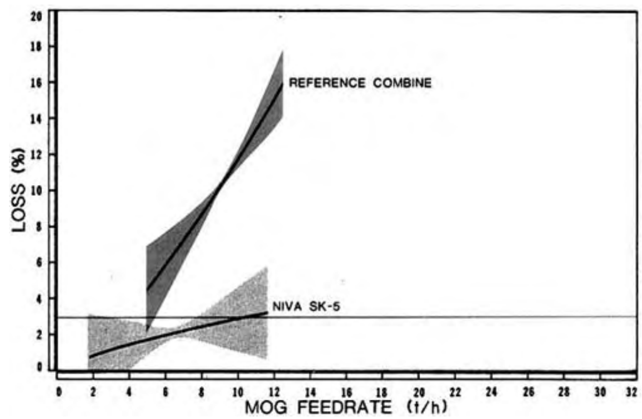


FIGURE 17. Total Grain Losses for the Niva SK-5 and the PAMI Reference Combine in Neepawa Wheat at 12.0% Grain Moisture Content.

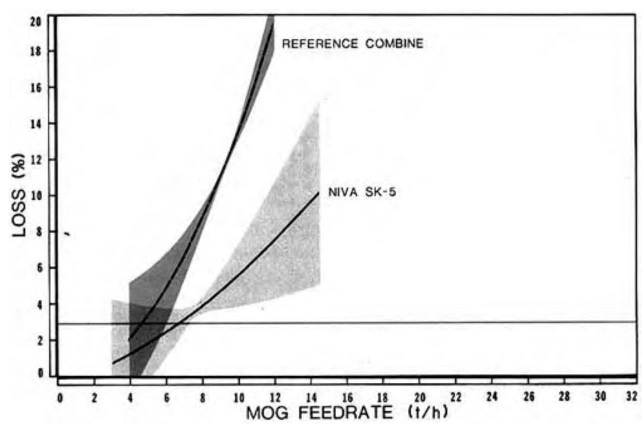


FIGURE 18. Total Grain Losses for the Niva SK-5 and the PAMI Reference Combine in Bonanza Barley.

OPERATOR SAFETY

Comprehensive safety sections were included in both the combine and engine operator's manuals. The Niva SK-5 had adequate warning decals, but was not equipped with a Slow Moving Vehicle sign. Since a sign is required for transport on public roads in most Canadian provinces, the distributor should install an SMV sign before delivery to the dealer. The Niva SK-5 was not equipped with warning lights or rear view mirrors. The manufacturer should consider adding both to improve safety in road transport due to limited visibility on the right of the combine.

Shielding on the Niva SK-5 was excellent, and gave good protection from all moving parts. Most shields were hinged and easily opened for servicing, thereby discouraging the practice of permanent shield removal.

The Niva SK-5 was equipped with a header lock and its proper use was emphasized in the operator's manual. The header lock must be used when working beneath the header, such as when cleaning the stone trap.

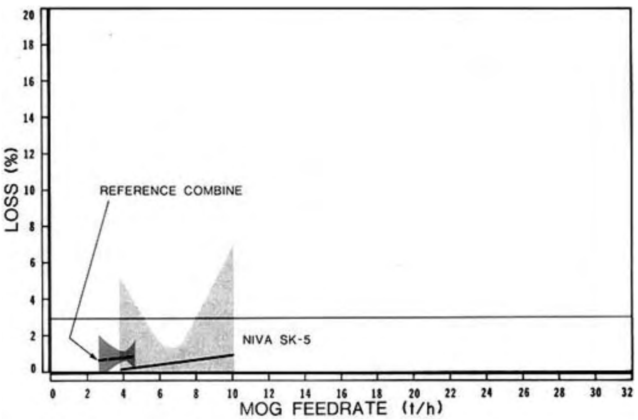


FIGURE 19. Total Grain Losses for the Niva SK-5 and the PAMI Reference Combine in Linott Flax.

The ladder for cab and engine access was safe, convenient and equipped with adequate railings.

Care must be taken when servicing the engine, to avoid slipping and falling from the combine.

Care must be taken to remove the rocking wrench from the feeder shaft hub if it has been used for unplugging the table auger. Serious injury could result if the wrench is not removed.

The grain tank must not be entered when the engine is running. Entering the grain tank for cleaning was both difficult and hazardous due to the small size of the access port.

The flexible seat backrest (FIGURE 2) was hazardous. The operator would often lean upon the backrest for support when stepping down into the cab and would fall forward as the backrest pivoted. It is recommended that a lock be provided on the seat backrest.

If recommended safety procedures were followed, all adjustments could be safely made. Since the Niva SK-5 was designed for a factory installed straw and chaff buncher, it was equipped with rotating straw buncher feed fingers and feed pan (FIGURE 20) directly behind the shoe. Extreme care had to be taken when hand sampling shoe losses while the combine was running to avoid contact with the feed fingers. The straw buncher feed fingers were not required in dry crops, however, they were required in damp barley and in green crops to prevent chaff build-up behind the shoe.

FIGURE 20. Straw Buncher Feed Finger Assembly.

The grease fitting on the inboard bearing of the upper railings cross auger, was hazardous to service.

A fire extinguisher should be carried on the combine at all times.

OPERATOR'S MANUAL

Operator's manuals in both English and Russian were supplied with the Niva SK-5 for the combine, the engine and the automatic feed control. No operator's manual was supplied for the factory installed loss monitor. The English operator's manuals were a direct translation of the Russian manuals. They were very wordy and quite difficult to understand mainly due to inadequate translation.

The manuals contained three dimensional cut away views of most combine components. These aided in repair and adjustment in many cases but were inadequate in other cases. For example, although a lengthy description was provided on the shoe, instructions for removing and replacing the sieves were not included.

The procedure outlined in the operator's manual for adjusting the variable speed traction drive was incomplete and resulted in deformation of the pivot clevis and drive belt misalignment if followed in detail.

The lubrication section in the operator's manual was confusing and incomplete. Thirty-three grease fittings were not included in the lubrication chart.

No suggested combine settings for various crops were provided in the operator's manuals, although suggested settings for several crops, as well as many operating instructions, were included on decals attached to various parts of the combine.

Some of the controls and components described in the operator's manual did not correspond to those on the combine. It is recommended that the operator's manual for the Niva SK-5 be revised, corrected and updated.

DURABILITY RESULTS

TABLE 5 outlines the mechanical history of the Belarus Niva SK-5 combine during 169 hours of operation while combining about 354 ha (873 ac). The intent of the test was evaluation of functional performance. The following failures occurred during functional testing, An extended durability evaluation was not conducted.

TABLE 5. Mechanical History

Item	Operating Hours	Field Area ha	Field Area (ac)
Hydraulic System			
-The hydraulic system was flushed and the oil replaced to remove sludge, paint and metal cuttings at	20	41	(101)
-The main hydraulic pump shifter clutch began jumping out of gear under load, The shifter fork and clutch jaws were modified to eliminate the problem at	20	41	(101)
-The header hydraulic control lever wore out at the pivot shaft attaching point and was rebuilt at	75	176	(435)
-The header hydraulic control lever wore out again. Both the lever and pivot shaft were replaced at	101	236	(583)
-Oil began leaking from the header lift spool valve at	111	266	(657)
-The main hydraulic line burst at the relief valve coupling and was replaced at	150	324	(801)
Drives			
-The unloading auger final drive chain jumped off due to sprocket misalignment. The drive was aligned and the chain replaced at	2	4	(10)
-The unloading auger final drive chain broke due to sprocket misalignment. The drive shaft was shimmed to prevent misalignment and the chain repaired at	72	169	(418)
-The variable speed traction drive pivot clevis bent, while tightening the traction drive belt and was straightened at	13	24	(59)
-The header drive chain broke and was repaired at	33	76	(188)
-The header drive belt cracked requiring replacement at	70	163	(403)
This recurred at	95	222	(549)
-The lower left tailings elevator bearing failed damaging the auger shaft, bearing retainer and seal. All were replaced at	74	174	(430)
-One grain unloading auger pivot junction drive cog broke when folding the auger into working position at	138	312	(771)
Engine			
-Intermittent problems with air entrainment in the fuel system began occurring at	85	196	(484)
-Oil began leaking from the turbocharger at	111	266	(657)
-The oil leak became severe requiring turbocharger replacement at	124	292	(722)
Cylinder and Concave			
-The left front concave adjusting bolt broke and was rewelded, and two bars on the front concave segment bent and two feeder slats bent when a stone entered the cylinder at	85	196	(484)
Miscellaneous			
-The lower tailings inspection door hinge broke and was repaired at	164	343	(848)
-The batteries required replacement at	End of Test		

DISCUSSION OF MECHANICAL PROBLEMS

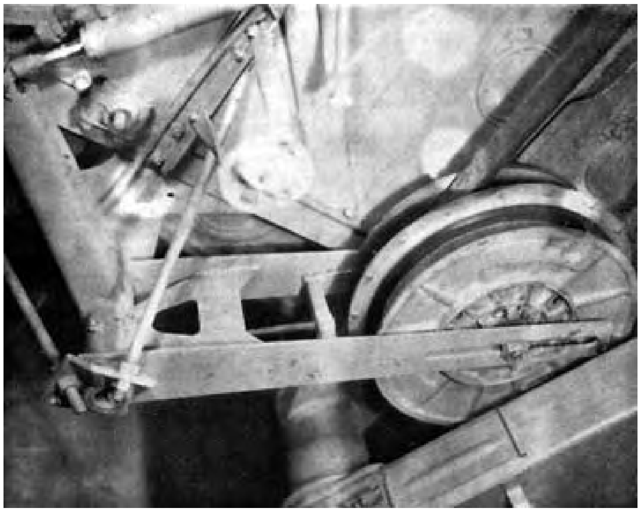
VARIABLE SPEED TRACTION DRIVE

The variable speed traction drive performed well, however, during initial adjustment (needed due to belt stretching), the pivot clevis (FIGURE 21) bent when following adjusting procedures outlined in the operator's manual. To maintain belt alignment during adjustment it was necessary to wedge the left side of the inner adjusting clevis to prevent clevis deformation from the belt load. Modifying the pivot clevis assembly to prevent bending during adjustment or modifying the belt tightening procedure in the operator's manual are required.

HYDRAULIC PUMP CLUTCH

The main hydraulic pump was equipped with a jaw-clutch to facilitate cold weather starting. The clutch began disengaging under load. The pump was removed and it was found that the jaw-clutch had never been properly adjusted at the factory and was engaging only on the corners of the jaws, which had become worn. The jaw faces were reground, and the shifter fork assembly was bent to provide full jaw engagement. No further problems occurred.

FIGURE 21. Traction Drive Adjustment.



ENGINE TURBOCHARGER

The turbocharger began leaking oil out the discharge air port. The subsequent chaff build up caused a fire which was extinguished before it had damaged any components. Leakage could possibly have been initiated by restricted air filters. The turbocharger was removed and disassembled, and the oil slingers were found to be worn excessively. Since no replacement parts were available, a new turbocharger was installed. The primary and secondary air filters were replaced, and a centrifugal pre-cleaner was installed since the original pre-cleaner had a coarse screen resulting in quick plugging of the primary air filter. No further problems occurred.

ENGINE FUEL SYSTEM

An aggravating problem throughout the last half of the test was intermittent air entrainment in the fuel system causing loss of power, rough idling and poor starting. Complete bleeding and repriming of the fuel system would result in normal operation for a limited time. By the end of the test all connections had been checked and all filters and the hand priming pump had been replaced. Although replacement of the hand priming pump reduced the problem, air entrainment still occasionally occurred apparently at the hand priming pump. Local distributor service personnel were unable to correct the problem.

HEADER DRIVE BELT

The header drive belt failed twice. Both belts cracked on the inside edge, possibly due to the severe reverse bend over the drive tightener. A shorter drive belt may increase belt life by reducing the reverse bend.

TAILINGS ELEVATOR

Failure of the left lower bearing on the tailings elevator damaged the tailings auger shaft, bearing housing, and inboard bearing seal. Only the bearing was included in the spare parts kit. Most bearings on the Niva SK-5 are of a unique design, not compatible with North American bearings, requiring special tools for removal and mounting. The special tools are supplied with the combine and function adequately.

COMBINE PRE-DELIVERY

Many minor problems occurred initially with the Niva SK-5. Most of these were due to improper combine pre-delivery, poor instruction manuals and distributor service personnel unfamiliar with the combine. Most of these problems could be eliminated by proper procedures at the distributor level.

APPENDIX I
SPECIFICATIONS

MAKE:	Belarus Niva Self-propelled Combine
MODEL:	SK-5
SERIAL NUMBER:	Header N235, Combine body N-3-8351, Engine 75438214
MANUFACTURER:	Tractoroexport Rostselmash Rostov-on-Don, U.S.S.R.
WINDROW PICKUP:	
-- make and model	Melroe 351-12
-- serial number	MB 8148
-- type	alumimum apron with rubber draper
-- pickup width	3200 mm (126 in)
-- number of belts	7
-- teeth per belt	40
-- type of teeth	spring steel
-- number of rollers	
-- apron	2
-- draper	2
-- height control	support chains
-- speed control (combine)	variable pitch sheaves hydraulically controlled
-- apron speed range	150 to 320 rpm
-- draper speed range	185 to 400 rpm
HEADER:	
-- type	centre feed, full floating
-- width	4420 mm (14.5 ft)
-- auger diameter	508 mm (20 in)
-- feeder conveyor	3 roller chains, undershot slatted conveyor
-- conveyor speed	2.9 m/s (573 ft/min)
-- range of pickup height	-100 to 730 mm (-4 to 29 in)
-- number of lift cylinders	2
-- raising time	6 s
-- lowering time	3 s
FEEDER BEATER:	
-- type	four wing drum
-- diameter	195 mm (7.69 in)
-- speed	700 rpm
CYLINDER:	
-- type	rasp bar
-- number of bars	8
-- diameter	600 mm (23.63 in)
-- width	1185 mm (46.63 in)
-- drive	crank controlled variable pitch belt
-- speed range	
-- low gear	325 to 600 rpm
-- high gear	750 to 1360 rpm
-- stripper	3 mm (0.13 in)bar fabric belting
CYLINDER BEATER:	
-- type	four wing box
-- speed	845 rpm
CONCAVE:	
-- type	bar and wire grate, two segment
-- number of bars	
-- front segment	7
-- rear segment	12
-- configuration	18 intervals with 5 mm (0.19 in) wires and 12 mm (0.47 in) spaces
-- area	1.01 m² (1567 in²)
-- transition grate area	0.27 m² (426 in²)
-- wrap	146 degrees
-- grain delivery to shoe	grain pan
STRAW WALKERS:	
-- type	rotary, fin and wire
-- number	4
-- length	3618 mm (142 in)
-- total width	1177 mm (46.38 in)
-- separating area	4.26 m² (6600 in²)
-- throw	100 mm (4 in)
-- speed	205 rpm
-- grain delivery to shoe	closed bottom walkers
SHOE:	
-- type	opposed action
-- throw	55 mm (2.17 in)
-- speed	260 rpm
-- chaffer sieve	adjustable lip, 1.16 m² (1800 in²)
-- clean grain sieve	adjustable lip, 0.97 m² (1509 in²)
CLEANING FAN:	
-- type	5 blade undershot
-- diameter	570 mm (22.44 in)
-- width	888 mm (35 in)
-- drive	crank controlled variable pitch belt
-- speed range	460 to 700 rpm

ELEVATORS:	
-- type	roller chain with rubber flights and bottom delivery
-- clean grain (bottom drive)	130 x 225 mm (5.13 x 8.88 in)
-- tailings (bottom drive)	130 x 225 mm (5.13 x 8.88 in)
GRAIN TANK:	
-- volume	2.8 m³ (77 bu)
-- unloading time	75 s
ENGINE:	
-- make	Tractoroexport
-- model	SMD-17K
-- type	4 stroke turbocharged diesel
-- number of cylinders	4 displacement 6.33 L (386 in³)
-- governed speed (full throttle)	2040 rpm
-- SAE rating @ 1900 rpm	82 kW (110 hp)
-- fuel tank capacity	190 L (42 Imp. gal)
CLUTCHES:	
-- header	V-belt
-- separator	dry friction disk
-- unloading auger	dog clutch with friction disk assist
-- traction drive	dry friction disk
NUMBER OF CHAIN DRIVES:	8
NUMBER OF BELT DRIVES:	14
LUBRICATION POINTS:	
-- 10 h lubrication	2
-- 60 h lubrication	21
-- 240 h lubrication	35
-- unspecified lubrication time	33
TIRES:	
-- front	2, 530 x 610 (20.9 x 24), 10-ply
-- rear	2, 310 x 406 (12.2 x 16), 8-ply
TRACTION DRIVE:	
-- type	hydraulically controlled variable pitch belt
-- speed ranges with 530 x 610 tires	
-- 1st gear	1.4 to 3.0 km/h (0.9 to 1.9 mph)
-- 2nd gear	3.8 to 7.7 km/h (2.4 to 4.8 mph)
-- 3rd gear	9.5 to 20.0 km/h (5.9 to 12.4 mph)
-- reverse	3.7 to 8.1 km/h (2.3 to 5.0 mph)
OVERALL DIMENSIONS:	
-- wheel tread (front)	2420 mm (95 in)
-- wheel tread (rear)	1215 mm (48 in)
-- wheel base	3540 mm (139 in)
-- transport height	4020 mm (158 in)
-- transport length	8980 mm (354 in)
-- transport width	4390 mm (173 in)
-- field height	4020 mm (158 in)
-- field length	8890 mm (350 in)
-- field width	6850 mm (270 in)
-- unloader discharge height	2870 mm (113 in)
-- unloader clearance height	2900 mm (114 in)
-- unloader reach	2560 mm (101 in)
-- turning radius	
-- left	9800 mm (386 in)
-- right	6910 mm (272 in)
-- clearance radius	
-- left	11,600 mm (457 in)
-- right	9960 mm (392 in)
WEIGHT: (with empty grain tank)	
-- right front wheel	2750 kg (6060 lb)
-- left front wheel	3430 kg (7650 lb)
-- right rear wheel	625 kg (1380 lb)
-- left rear wheel	610 kg (1350 lb)
TOTAL	7415 kg (16,350 lb)
OPTIONAL EQUIPMENT:	
-- straw and chaff collector	

APPENDIX II
STATISTICAL SIGNIFICANCE OF CAPACITY RESULTS

The following data are presented to illustrate the statistical significance of the capacity results shown in FIGURES 13 to 16. This information is intended for use by those who may wish to check results in greater detail. Sufficient information is presented to permit calculation of confidence belts.

In the following table for the Belarus Niva SK-5 combine, C = cylinder loss in percent of yield, S = shoe loss in percent of yield, W = straw walker loss in percent of yield, F = the MOG feedrate in t/h, while ln is the natural logarithm, Sample size refers to the number of loss collections. Limits of the regressions may be obtained from FIGURES 13 to 16 while crop conditions are presented in TABLE 4.

CROP — VARIETY	FIG NO.	REGRESSION EQUATIONS	SIMPLE CORRELATION COEFFICIENT	STANDARD ERROR OF SLOPE	RESIDUAL MEAN SQUARE	MEAN FEED-RATE	SAMPLE SIZE
WHEAT — Neepawa	13	$C = 1.12 + 0.02F$	0.16	0.06	0.11	7.39	6
		$S = -0.10 + 0.04F$	0.78	0.02	0.01		
		$\ln W = -11.89 + 5.51 \ln F$	0.95	0.93	0.39		
WHEAT — Neepawa	14	$\ln C = -3.83 + 1.94 \ln F$	0.95	0.39	0.02	9.73	5
		$\ln S = -6.64 + 1.74 \ln F$	0.73	0.93	0.13		
		$\ln W = -16.98 + 7.51 \ln F$	0.91	2.01	0.61		
BARLEY — Bonanza	15	$\ln C = -1.28 + 0.29 \ln F$	0.64	0.16	0.04	7.71	7
		$S = -0.06 + 0.09F$	0.94	0.02	0.02		
		$\ln W = -3.83 + 2.26 \ln F$	0.94	0.36	0.22		
FLAX — Linott	16	$C = -0.07 + 0.05F$	0.98	0.01	0.001	6.62	5
		$S = -0.21 + 0.06F$	0.78	0.03	0.02		
		$\ln W = -7.04 + 2.57 \ln F$	0.91	0.68	0.27		

APPENDIX III
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

APPENDIX IV
METRIC UNITS

In keeping with the Canadian metric conversion program, this report has been prepared in SI units. For comparative purposes, the following conversions may be used:

1 kilometre/hour (km/h)	= 0.62 miles/hour (mph)
1 hectare (ha)	= 2.47 acres (ac)
1 kilogram (kg)	= 2.2 pounds (lb)
1 tonne (t)	= 2204.6 pounds (lb)
1 tonne/hectare (t/ha)	= 0.45 ton/acre (ton/ac)
1 tonne/hour (t/h)	= 36.75 pounds/minute (lb/min)
1000 millimetres (mm) = 1 metre (m)	= 39.37 inches (in)
1 kilowatt (kW)	= 1.34 horsepower (hp)
1 litre/hour (L/h)	= 0.22 Imperial gallons/hour (gal/h)

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