5. AGGREGATING THE TRACTOR

General information provided in this Section will help to use efficiently the BELARUS 1523/1523B/1523.3/1523B.3 with a great variety of machines and implements (hereinafter referred to as the machines or technical facilities) to be used in the agriculture.
Aggregating the tractors with other machines involves a complex of operations related to selection of machines, determination of feasibility and techniques of attaching the machines to the tractor, with the tuning and adjustment of units and mechanisms of all the components of a machine-tractor aggregate (MTA).
As regards the method of ganging (aggregating) with tractors, all the agricultural machines (implements) are classified as follows:

- **The tractor-mounted** ones are to be attached to the tractor's three-point hitch linkage. The machine weight in the transport position is fully transferred to the tractor.
- **The semi-mounted** ones are to be attached to the three-point hitch linkage run on supporting wheels. The machine weight in the transport position is partly transferred onto the tractor and partly is supported by the wheels of its own. When rearranging the machine from the working position to the transportation one, the point of attachment to the tractor is forcedly shifted to a new position as to height.
- **The semi-trailed** ones are to be attached in the same way as the semi-mounted are, but when rearranging the machine from the working position to the transportation one, the point of attachment to the tractor does not change its position as to height.
- **The trailed** ones are to be attached to the haul-and-draw coupling arrangement of the tractor. The machine weight is carried by its own running gear. When rearranging the machine from the working position to the transportation one, the point of attachment to the tractor does not change its position as to height.
- **The fitted** ones are to be attached to the tractor by means of additional assembly units using the mounting holes available on the tractor. The machine weight is fully taken by the tractor. Installation of fitted machines shall be only done subject to the approval of the Manufacturer. In case of installation of a machine unauthorized by the Manufacturer, all the consumers' claims and unsatisfactory equipment reports shall be sent to the entity which has installed and checked the equipment.

The Belarus tractors are equipped with various working equipment to be used for aggregating in standard and optional kits thus providing a means for coupling and joint operation of all the agricultural machines and implements which comply with tractor's hitch and/or haul-and-draw mounting dimensions and energy requirements. In addition, the provision of a power take-off shaft (PTO) and free outlets of the hydraulic system make it possible to drive tools of the attached machines/technical facilities by either mechanical or hydrostatic method.

This Section contains the information on the working equipment intended for aggregating with the tractor; the methodology of choosing the machines for aggregating with the above-stated tractors as well as admissible loads and speed regimes of the tractor when combined in a machine-tractor aggregate.

5.1 ADJUSTING THE WHEEL TRACK

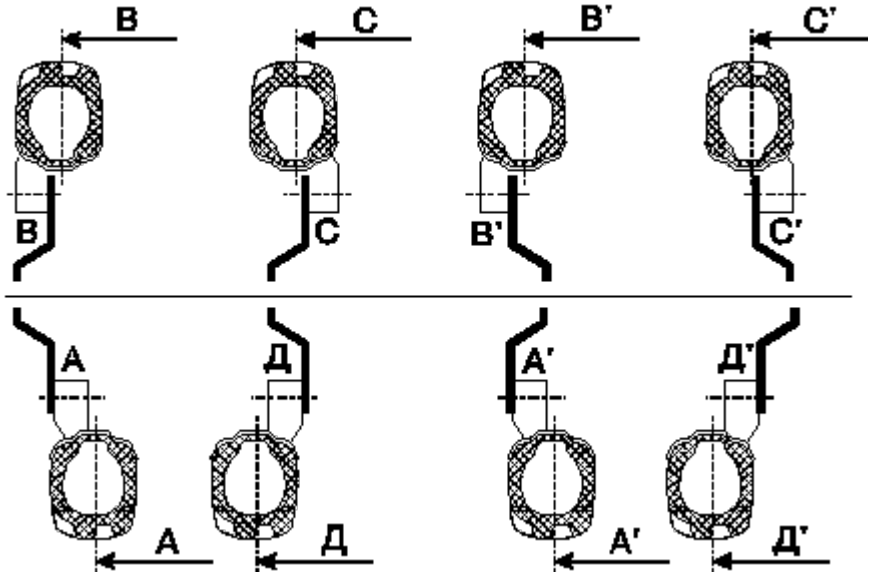
Front Wheels

With the standard tyres 420/70R24

Wheel position	Wheel track, mm
A	1540
B	1635*
C	1850
Д	1950
A’	1700
B’	180
C’	2020
Д’	2090

The positions of wheels with inverted disks (primed letters) should be only used in exceptional cases.

*As shipped from the Manufacturer.



A, B, C, Д — standard installation of the disk with a remounted rim;
A’, B’, C’, Д’ — re-arrangement of the disk and the rim.

Rear wheels

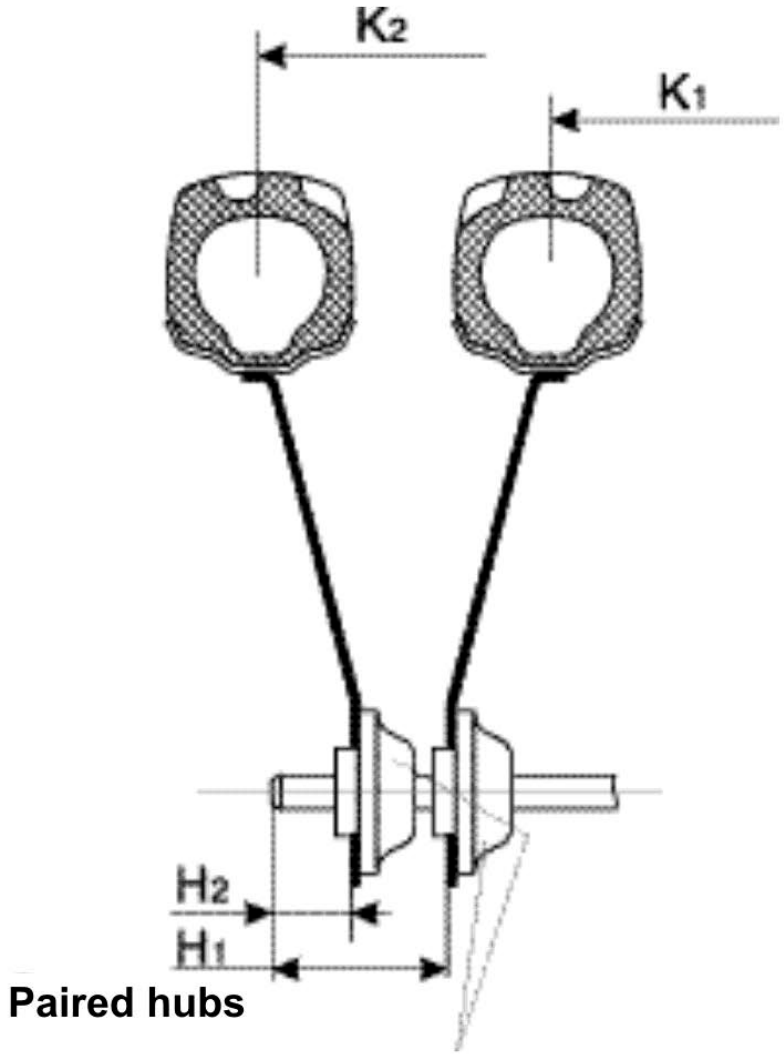
Tyre standard size	Wheel position	Wheel track width K, mm	Hub mounting dimension* H to half-axle end-face, mm
520/70R38	A C	1600…1900 1950…2440	155…5 245…0
18,4R38	A C	1480…1900 1950…2440	215…5 245…0

**Changing the wheel track by the amount of n corresponds to a shift in the hub position by n/2 from each side.

5.2 TWINNING THE REAR WHEELS TO REDUCE THE SPECIFIC PRESSURE OF THE GROUND

Tyre standard size in package	Wheel track width K_1, K_2, mm	Hub mounting dimension H_1, H_2, mm	Remarks
520/70R38 + + distance piece + + 520/70R38	K_1 = 1500 K_2 = 2930	H_1 = 190	distance piece * 1522-3109020
18.4R38 + + 18.4R38	K_1 = 1480 K_2 = 2440	H_1 = 215 H_2 = 0	Paired hubs

*The distance piece 1522-3109020 intended for twinning the wheels from optional additional package can be used instead of hub pairing.



Paired hubs

5.3 INTER-ROW CULTIVATION OF ROW CROPS ON TYRES OF STANDARD TYRE PACKAGE

Inter-row widths M, mm	Wheel track K, mm		Main row crops
	front	rear	
	420/70R24	520/70R38 18.4R38	
800 900 1000	1540 (A) 1800 (B′) 2020 (C′)	1600 1800* 2000	* Potato in drills, corn, cotton

Tyre parameters

Tyre standard size	Sectional width, mm	Static-load tyre radius, mm	Tyre package
420/70R24	420	569	standard
520/70R38	520	795	
18.4R38	467	805	additional
11.2R24	284	567	
11.2R42	284	745	

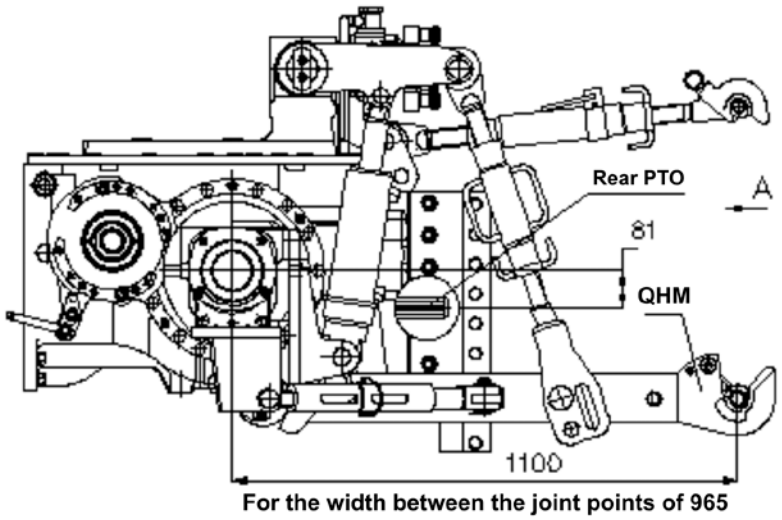
Protective Margins for the Tractor Wheels during the Row-Crop Cultivation

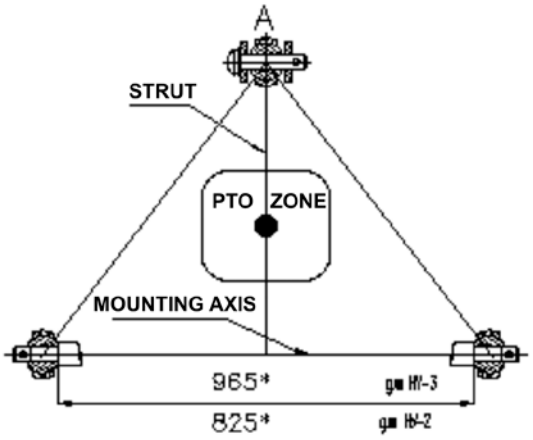
Basic crops	Protective margin, mm
Beet	80
Corn	120
Potato in drills	200
Cotton	200

5.4 HITCH AND HAUL-AND-DRAW COUPLERS

Rear Hitch Linkage

For machines: mounted and semi-mounted





Type of hitch arrangement (category)		НУ-3 (Cat. 3)	НУ-2 (Cat. 2)
Lower links		One-piece, with QHM ***	
Lower link length, mm		1060	
Hinge width, mm	of the top link	51	
	of the lower links	45	
Nominal diameter of coupling elements, mm	pin of the top link	32	25
	hinges of the lower links	37	28
Distance from the PTO end-face to the mounting axis, mm			
Carrying capacity, kN	at the mounting axis	68	
	at the 610-mm overhang	45	
Machine support height *			610

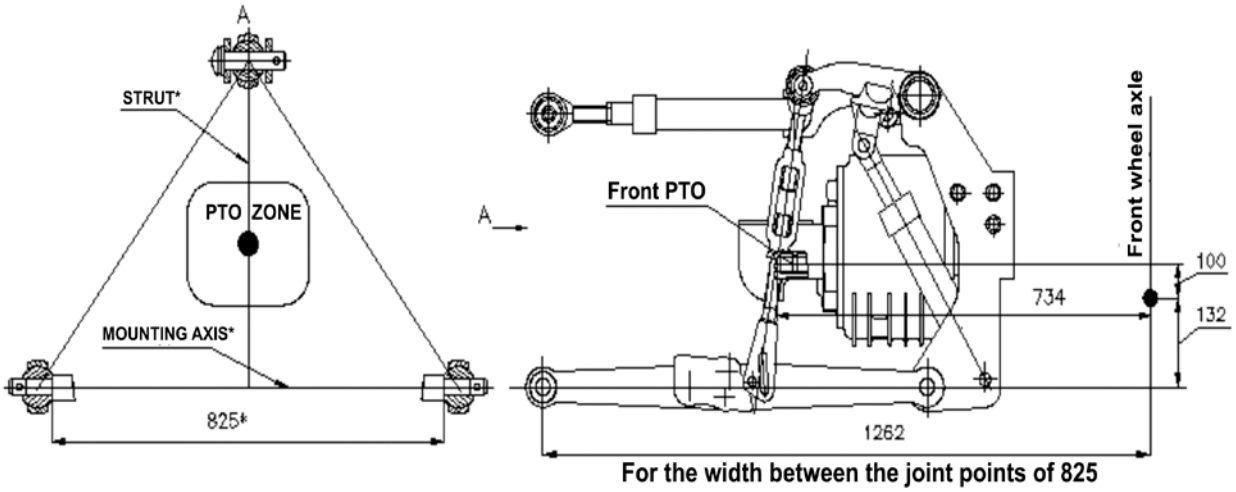
* Dimensions attributed to the machine to be attached.

** PTO 3 tail-piece.

*** QHM – a quick-hitch mechanism with replaceable hinges, Cat. 3 and 2.

Front Hitch Linkage

For machines: mounted and semi-mounted

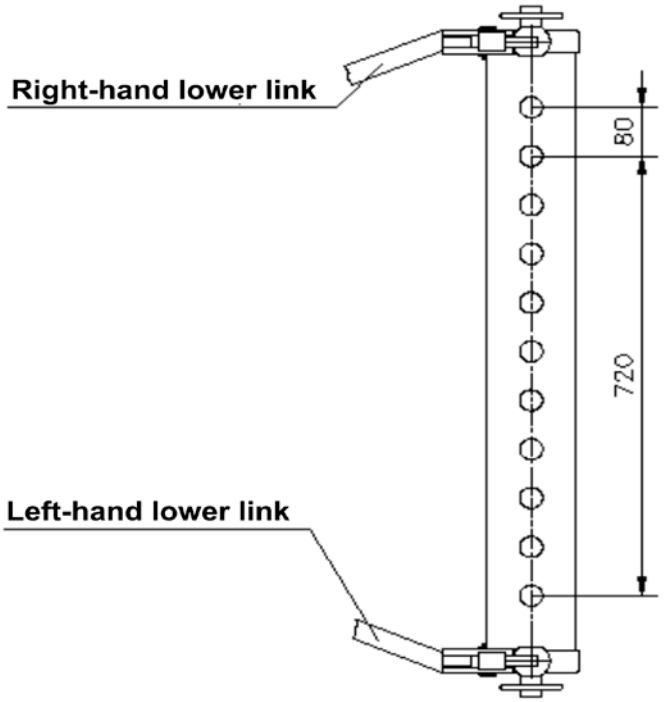


Type of hitch arrangement (category)		НУ-2 (Cat. 2)
Lower links		Composite, with rolled-in hinges
Lower link length, mm		885
Hinge width, mm	of the top link	51
	of the lower links	45
Nominal diameter of coupling elements, mm	pin of the top link	025
	hinges of the lower links	028
Distance from the PTO end-face to the mounting axis, mm		550
Carrying capacity, kN	at the mounting axis	25
	at the 610-mm overhang	23
Machine support height *		610

*Dimensions attributed to the machine to be attached.

Haul-and-Draw Coupler ТСУ-1 (cross-bar)

For machines: semi-mounted (seed planters, potato planters, potato harvesters, vegetable harvesting machines, and others), semi-trailed (mowers, pickup bailers, root-vegetable top harvesters, fertilizer placers, etc.); trailed (disk harrows, soil cultivation units, stubble breakers, trains of coupled harrows, cultivators, seed planters, etc.).



Hitch coupler type	ТСУ-1
	a crossbar at the mounting axis of the rear hitch linkage
Distance from the PTO end-face to the mounting axis, mm	668 (654*)
Coupling pin diameter, mm	☐30

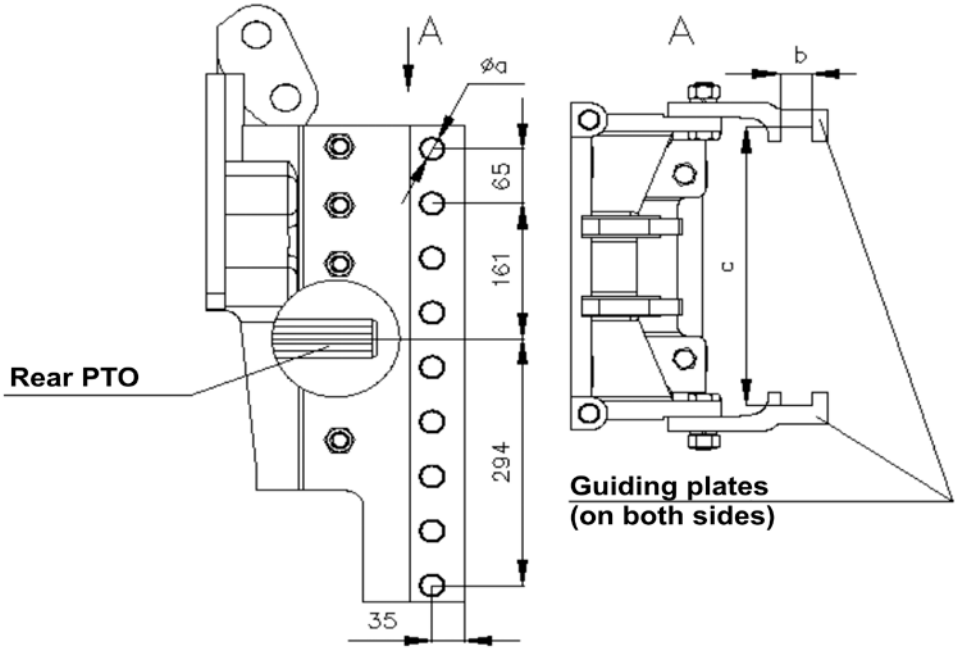
*PTO 3 tail piece

ATTENTION!!

- The ТСУ-1 coupler is intended for joint operation with agricultural machinery **at a speed not exceeding 20 km/h and fitted with a hitch yoke of their own** to be attached to the crossbar.
- **Aggregating** the trailers and/or semitrailers (of special- or general-purpose) with the tractor by means of the ТСУ-1 coupler **is strictly prohibited**.

Lift Coupler

Purpose: to fasten the hitch and haul-and-draw couplers of appropriate coupling dimensions.



Lift coupler	Vertical guiding plates are made with holes		
Special features	Possibility of changing the position of hitch couplers as to height in 65-mm steps		
Version of make installed**	Version “1”	Version “2”	Version “3”
Hole diameter “a”, mm	24		20
Slot width “b”, mm	34		30
Dimension over slots “c”, mm	330		
Distance from the PTO end-face to coupling holes axis of the guiding plates, mm	55 (41*)		

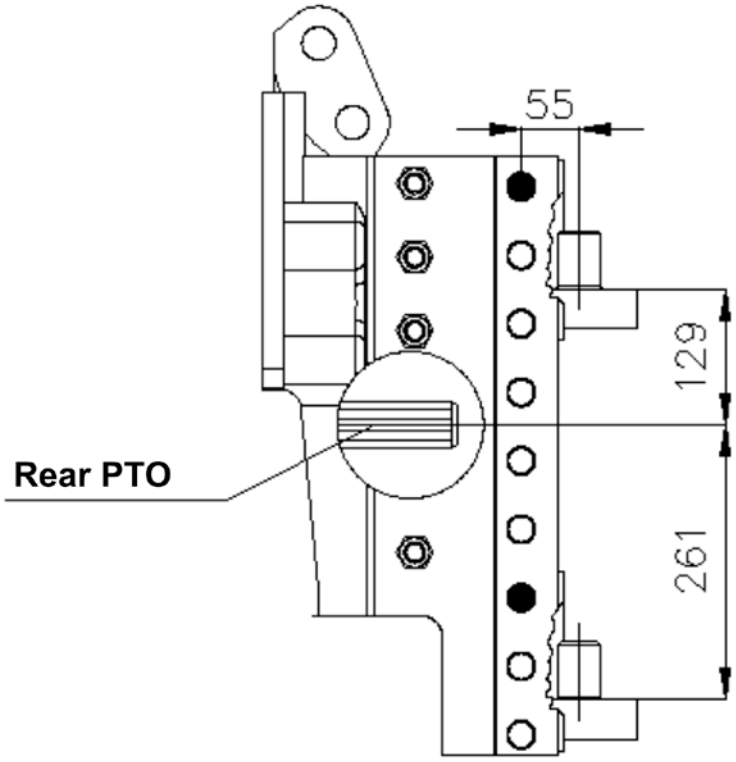
* PTO 3 tail piece.

** Version “1” is used in the standard kit. In Version “2” there is no top hole in the guid-ing plates.

Certified hitch couplers of other manufacturers make with suitable coupling dimensions may be used subject to mandatory adherence to permissible loads.

Haul-and-Draw Coupler ТСУ-2Р

For machines: semi-trailed (semi-trailers, fertilizer placers, etc.); pull-type (disk harrows, soil cultivation units, trains of coupled harrows, cultivators, seed planters, etc.).



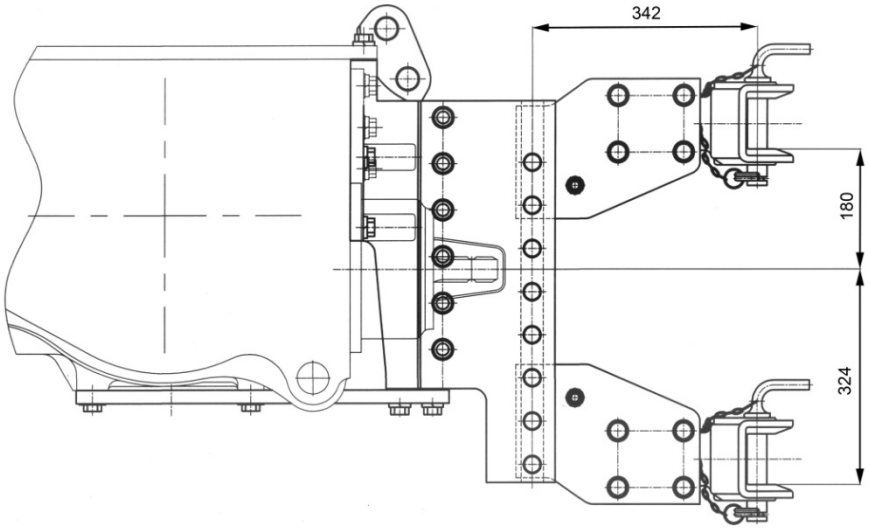
Type of the hitch coupler	Coupler ТСУ-2Р (Python)
	Cantilevered pin, free to be relocated stepwise in the vertical plane with the increments of 65 mm.
Position of the yoke for PTO-driven machines	Below or above the PTO axis
Distance from the PTO end-face to the mounting axis, mm	110(96*)
Coupling pin diameter mm	40
Vertical load on the coupler, kN	25

* PTO 3 tail piece

ATTENTION! NEVER install the above coupler at the 1st and 2nd holes from the bottom

Haul-and-Draw Coupler ТСУ-3В

For machines: pull-type (2-axle trailer of an automobile-type and others); semi-trailed (mowers, pick-up hay bailers, haulm removing machines, etc.).



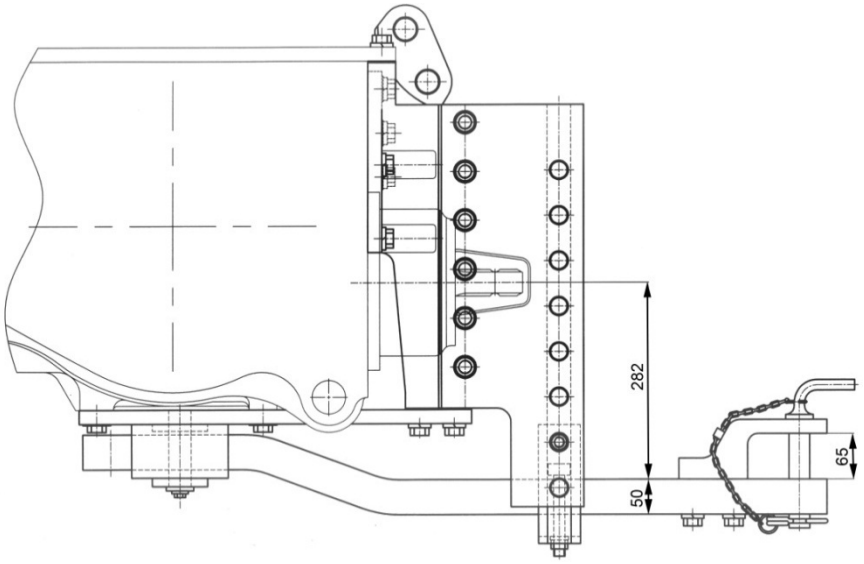
Type of the hitch coupler	Coupler ТСУ-3В
	a yoke with the possibility of stepwise displacement with increments of 65 mm
Position of the yoke for PTO-driven machines	below the PTO axis
Distance from the PTO end-face to the mounting axis, mm	400
Vertical load on the coupler, kN	12

* PTO 3 tail piece

ATTENTION! NEVER install the above coupler at the 1st holes from the bottom.

Haul-and-Draw Coupler ТСУ-1М-01

For machines: semi-trailed (semi-trailers, fertilizer placers and the like); pull-type (disk harrows, soil cultivation units, trains of coupled harrows, cultivators, seed planters, etc.).



Type of the hitch coupler	Coupler ТСУ-1М-01	
	drawbar with the possibility of displacement in the horizontal plane with respect to the rear PTO end-face	
Distance from the PTO end-face to the mounting axis, mm	1st position	2nd position
	400(386*)	500 (486*)
Coupling pin diameter, mm	O30	
Vertical load on the HDL, kN	12	8

* PTO 3 tail piece.

The rear hitch linkage НУ-2(3) is made to Cat. 3, with a potential of being readjusted to Cat. 2 by replacing the independent joints of a quick-hitch mechanism (GHM). The provision of replaceable Cat. 3 and 2 joints makes it possible to carry out simple readjustments and to use agricultural machinery for Class 2 and 1.4 tractors in adverse weather conditions or on heavy-textured soils.

The left-hand drop link is set to 740 mm and needs no readjustment, but in case of exigency.

The drop links are provided in addition to the main hole for coupling to the lower links with a slot to join up the wide-span machines and to follow the field relief more closely (cultivators, planters, and others).

The automatic hitch couplers CA-2 and CA-1 can be provided for the rear and front hitch linkages, respectively.

A single crossbar ТСУ-1 is provided to be installed at the rear hitch linkage axis. When the PTO shaft is to be used, a universal-joint shaft with the nominal length of 1000 mm may be recommended. In this case the mounting axis should be located at the middle of the universal-joint shaft; otherwise the PTO will be overload.

The tractor is equipped with three pairs of free hydraulic system outlets intended for connection to attached technical facilities (if no front coupler НУ-2 is available).

The oil consumption through the outlets is 45…55 l/min. (depending on the technical condition of the hydraulic pump). The oil intake by the hydraulic cylinders should not exceed 25 l. The oil level in the hydraulic tank shall be carried out with the service cylinders rods fully drawn-in.

To avoid the oil losses when aggregating the technical means or in case of unexpected disconnection, the quick-hitch mechanisms, cut-off and break-off fittings are provided (male half-couplings and break-away couplings), which are delivered optionally in the tractor's SPTA kit.

ATTENTION! The hydraulic system of the attached machine shall be coupled to the tractor hydraulic system by means of quick-hitch couplings. The coupling devices of semi-trailed machines should have adjustable support.

The hydrostatic power take-off is possible through one of the outlets for driving the auxiliary hydraulic motors. To avoid overheating of the hydraulic system, the operating pressure shall not exceed 11 MPa that corresponds to the power of not more than 10 kW. To drain oil from the hydraulic motor bypassing the distributor, a separate pipeline is fitted.

The tractor incorporates the hydraulic valves and accessories with nominal cross-section Д = 12 mm and coupling thread M20x1.5. If necessary, the suitable adaptors with nominal cross-section of at least Д = 12 mm should be made by the user for connecting the machines with other fittings than those specified above.

The haul-and-draw coupler ТСУ-3В (lift type), page 181, and ТСУ-2Р (типа "Python"), page 180 are used as intended. The ТСУ-2В coupling element is located at the distance of 111 mm away from the PTO end-face and will accept a substantial vertical load with sufficient longitudinal stability of the aggregate. The ТСУ-3В yoke is located at the distance of 320 mm away from the PTO end-face, thus, making it possible to attach the semi-trailed and pull-up machines with active drive and providing a larger angle between the tractor and the facility while the aggregate is turning. To achieve the required handling criterion, the vertical load on the ТСУ-3В yoke is reduced as compared to that on the ТСУ-2В yoke.

The structure of lift outfit guiding plates provides for installation of coupling members (a hook instead of a yoke, or other) made by other manufacturers.

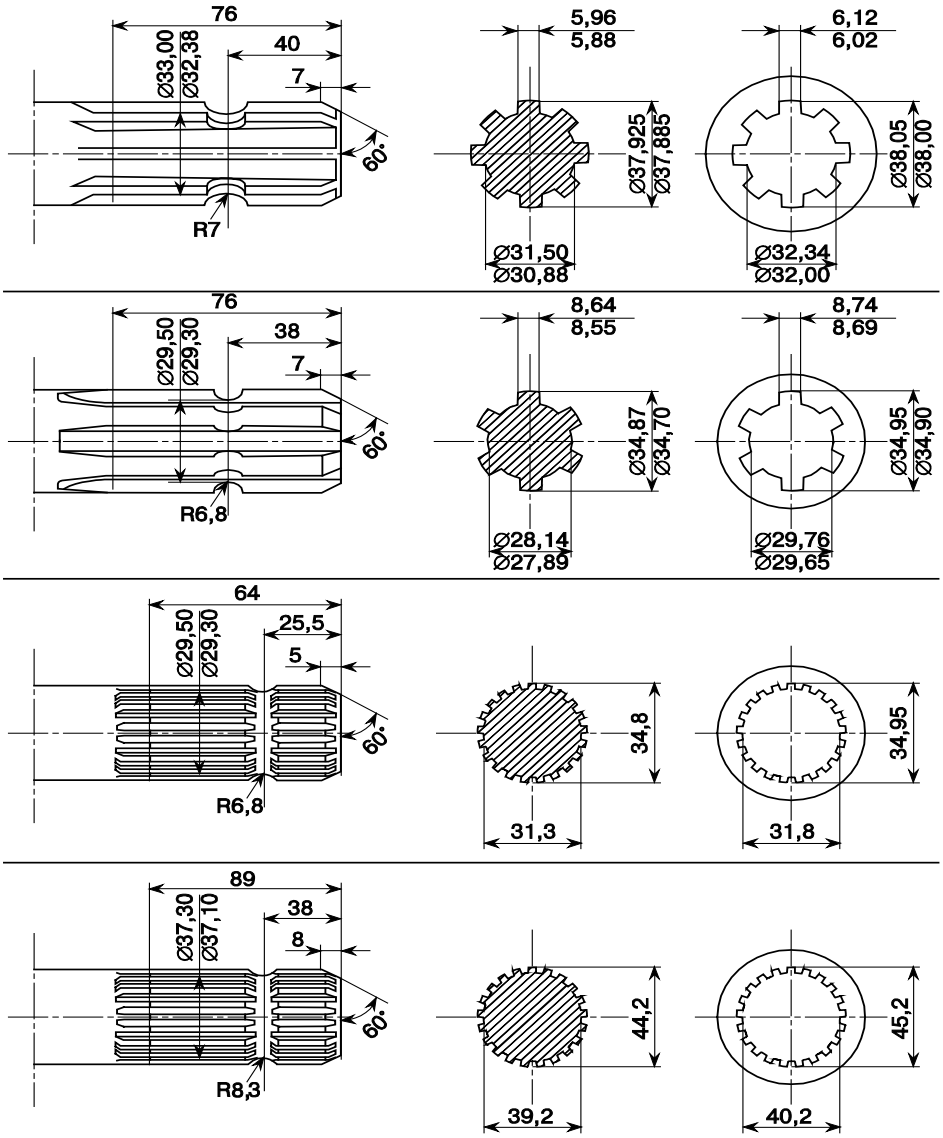
For aggregating the PTO-driven machines, a coupling arrangement ТСУ-1М-01 (a drawbar) with changeable position of the coupling member with respect to the Cat. 3 and 2 PTO (500 and 400 mm, respectively) is provided.

If the tractor is fitted with the ТСУ-1М-01 (a drawbar), the ТСУ-2Р ("Python") is not installed. When the ТСУ-1М-01 and ТСУ-2Р are installed, the coupler ТСУ-3В (a yoke) can be left in its upper position. Also, in all these cases no dismantling of the rear hutch linkage is required.

The front-mounted hitch coupler Type НУ-2 is similar to that of the rear one as to its design. It is mounted in place of the front counterweights and serves for making up the combined aggregates (a cultivator in front, seed planter in the rear, etc.), for mounting the echeloning implements (forward and side-mounted mowers, and others) as well as for transporting the certain machines from amongst rear-mounted combined aggregates in case of long trips.

5.5 PTO

Tractor: PTO tail-piece Machine: PTU shaft



PTO rpm	Tail-piece type Power transferred,	Rotational speed,		
kW (h.p.)				
		PTO	Engine	
Rear synchronised	BOM 1C и 1 BOM 2 и 3	3,8 r/m of the way 6,2 r/m of the way		60 (80)

Using the PTO

The PTO shaft is intended for driving the active tools of the agricultural machines. The tractors are equipped with the front and rear power take-off shafts (PTO). The front PTO is used either with the front hitch coupler or its bracket (with no links of the hitch coupler installed). It is intended for driving the front-end machines/units (rotary cultivators, mowers, pumps, etc.). The front PTO is installed optionally. The rear PTO provides for both independent and synchronous drive of machines, while the front one – only independent drive.

The rear synchronous PTO is only used in those cases, when the MTA should perform a certain number of operations over a given path (for example, sowing) and drive active wheels of machines based on trailers and semi-trailers; in this case, the tail-piece used does not matter. The ground speed should not exceed 10 km/h.

ATTENTION!

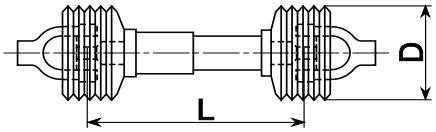
- **It is obligatory for the universal-joint shaft drive of the agricultural machines to be attached to have safety elements (overrunning and safety clutches).** The choice of overrunning and safety clutches depends on the type of the agricultural machine to be used as well as on the MTA operation mode. When the rear PTO is employed at 540 rpm and the front PTO at 1000 rpm. it is necessary to install a safety clutch on the side of the power take-up shaft (PTU); the clutch restricts the power take-off beyond the permissible limits (to no more than 60 and 50 kW, max., respectively). The safety clutch may be also installed for protecting from overload. To protect the PTO drive from overloading when combining the agricultural inertial-type machines with the tractor (pick-up presses, forage-harvesting complexes and the like), a universal-joint shaft together with an overrunning clutch fitted on the PTU side, shall be used.
- The telescopic universal-joint shafts provide the transfer of torque. The type of universal-joint forks and length of the universal-joint shafts is determined in accordance with the distance from the hitch point to the PTO and the PTU and the method of coupling of machines to the tractor. With the location of the PTU with respect to the PTO on the machine to be attached which conforms to standards, employment of standard-make universal-joint shaft is possible.
- It should be kept in mind that, when the distances from the hitch point to the PTO and the PTU differ (i.e., vastly larger or lesser), the uneven rotation arises and the manoeuvrability of the tractor-machine combination suffers. Thus, it leads to reduced reliability and violation of agricultural regime of the MTA. In this case, it is necessary to use a universal-joint shaft with the constant speed joints (it should be part of the agricultural machine kit).
- The PTO shall be disengaged:
  1. After the MTA is stopped (provided the operation cycle of the agricultural machine to be attached is terminated);
  2. When the agricultural machine is raised to its transport position (valid for semi-mounted and mounted agricultural machines);
  3. When making sharp turns (valid for semi-mounted, semi-trailed and trailed agricultural machines).
- It is recommended to disengage the universal-joint shaft from the tractor when on a prolonged running session to other locations.

- NEVER engage the PTO:
  1. With the tools of the agricultural machine (rotary cultivators and the like) lowered onto, or put deep into, soil;
  2. If the material used in the technological process is on working tools of the agricultural machine or the tools are clogged;
  3. When the angle of inclination (of deflection) of the cardan driveline exceeds 20 degrees in whatever plane.
- When attaching the agricultural machine (with an active drive), be sure to proceed as follows:
  1. Check to see if the speed regime to be selected corresponds to the type of PTO and PTU tail-pieces installed;
  2. Make sure that the inner forks of joints of the intermediate (telescopic) shaft are in the same plane, since non-observance of this requirement results in overload of the cardan driveline and the PTO mechanism;
  3. On installing the universal-joint shaft, make certain that the telescopic elements of the driveline do not abut tractor components and, also, the telescopic parts overlap sufficiently (110...120 mm), since at less overlap the driveline can get open;
  4. Lock the lower links to exclude any possibility of transverse displacement when mounted or semi-mounted agricultural machines/implements are attached;
  5. If required, limit the lift height of mounted and semi-mounted agricultural machines/implements into the transport position, to exclude the possible contact and damage of the universal-joint drive as well as to ensure a sufficient gap between the tractor and the agricultural machine/implement.

5.6 UNIVERSAL-JOINT SHAFTS WITH PROTECTIVE ENCLOSURE

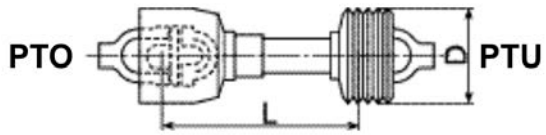
(accessory of the machine to be attached)

Universal-joint shaft of the type "10"



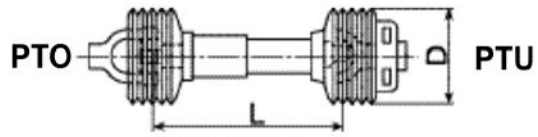
Telescopic, with universal joints and a protective enclosure.

Universal-joint shaft of the type "20"



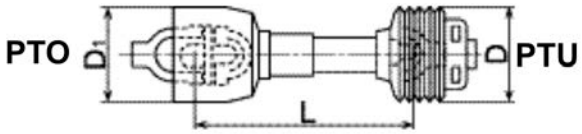
Telescopic, with a universal joint, a constant-velocity universal joint and a protective enclosure.

Universal-joint shaft of the type "40"



Telescopic, with protective enclosure and universal cardan joints with protective covering

Universal-joint shaft of the type “50”



Telescopic, with a safety coupling and constant-velocity universal joint with a protective enclosure.

Universal-joint shaft designation *	Torque, N·m	Universal-joint shaft length, mm		Enclosure diameter, D, mm	Standard
		L	L_1		
10.016	160	510	L_1 = 1,35 L	150	State Standard (GOST), ISO
10.040	400	560		175	
10.063	630	610 710		200	
10.1000	1000	610 710		220	

* Decimals after the point cover universal-joint shafts, type 20, 40, 50.

L is the distance between the centers for a fully drawn-in universal-joint shaft (nominal length).

L1 is the operating length of the universal-joint shaft.

D1= 1.75 is the diameter of a constant-speed universal joint enclosure.

5.7 Installation of the Universal-Joint Shaft

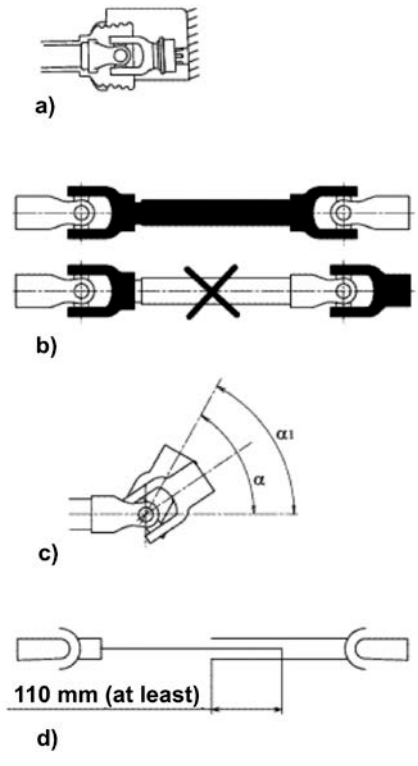
Type of universal-joint shaft	Hitch coupler	Tail-piece type	Universal-joint shaft nominal length, mm	Standard
"10" or "40"	НУ-3	PTO 1C, 1, 3	610; 710	State Standard (GOST)
	ТСУ-1Ж ТСУ-1 ТСУ-3В	PTO 1C, 1, 2	510	
		PTO 3	710	
"20" or "50"	ТСУ-2	PTO 1C, 1, 2, 3	710	

Installation of a universal-joint shaft with protective enclosure, together with the PTO hood, ensures safety of the joint.

The end yokes should be aligned in one plane

PTO	Universal joints inclination angle (deg., not more than)	
	Universal	constant-velocity cardan joint
Engaged	22	25 (50 for short period of time)

The overlapping of the shaft telescopic members shall be at least 110 mm to prevent separation and/or jamming of the connection



5.8 CONDITIONS OF SAFE AGGREGATING

To ensure the reliable and safe operation of the tractor, keep to recommendations for loading and stability specified in the Table below.

<table>
<tr><td colspan="3">Parameters determining the condition of a safe aggregating of the tractor within the MTA</td></tr>
<tr><td colspan="3">Permissible loads on the axles</td></tr>
<tr><td colspan="2">Tractor axle</td><td>Loads range, kN</td></tr>
<tr><td>Front</td><td>TF=10 mF</td><td>12...45</td></tr>
<tr><td>Rear</td><td>TR=10 mR</td><td>20...70</td></tr>
<tr><td colspan="3">Total maximum load on the tractor axles, kN</td></tr>
<tr><td colspan="2">T=TF+TR</td><td><90</td></tr>
<tr><td colspan="3">The range of basic weight parameters of the tractor-based MTA, kg</td></tr>
<tr><td>mF</td><td>mR</td><td>mT</td></tr>
<tr><td>1200...4500</td><td>2000.. .7000</td><td>9000></td></tr>
<tr><td colspan="3">The tractor operating weight without machine, m_{WTr}, is determined by tractor’s outfit and limited by the factors, as follows:
• Permissible axle loads.
• Total carrying capacity of tyres, used on the tractor.
• Running speed.
• Wheel tyre pressure.
• Wheel track size.</td></tr>
<tr><td colspan="3">Total axle load is subject to reduction in the following cases:</td></tr>
<tr><td>In case of twinning the wheels</td><td colspan="2">by 20 %</td></tr>
<tr><td>In case of augmentation of the wheel track beyond 1800 mm</td><td colspan="2">by 7% per each 100 mm of its increase</td></tr>
<tr><td colspan="2">Ksteer= mF/mRT</td><td>>0.2</td></tr>
<tr><td colspan="2">Total operating weight of the towed vehicle, kg</td><td><15000</td></tr>
<tr><td colspan="2">Total trailed operating weight, taking into account the critical longitudinal slope of 12 deg., kg</td><td>>12000</td></tr>
</table>

Where mF is the front axle part of the total tractor operating weight in aggregate with a machine or without machine; mR is the rear axle part of the total tractor op-erating weight in aggregate with a ma-chine

or without machine; mT is the maximum allowable weight of the tractor supported by the front and rear wheels; TF and TR are allowable loads on the front and rear axles, respectively; TT is the maximum permissible total load on the tractor axles and K steer is the steerability criterion.
The actual values of the weights mRT; mF; mR and mT are to be determined by weighing on a weigh-bridge or by any other available method. To determine mF and mR, the tractor shall be placed on the platform of special balance with its front and rear wheels, in turn; while the wheels of the other axle shall be on hard surface level with the balance platform.

ATTENTION!

- Load on the tractor front axle in an aggregate with an agricultural machine should be at least 20% (0.2) of the tractor own weight without attached machine. Otherwise, the tractor will not demonstrate sufficient steerability and longitudinal stability. The indicator of the load adequacy is a C-steer factor (see Table 7-20) which is a ratio between the front-wheel part of the total tractor + machine weight and the operating weight of the tractor without the machine.

- If the front axle load is insufficient, increase the tractor operating weight in accordance with recommendations of this Manual as regards the tractor loading and ballasting. In all instances, the total amount of loads shall not exceed the total load-carrying capacity of the tractor tyres specified in table of loads on the tyres (see Table 7-21)). If the load values obtained as the result of weighing, calculations and additional ballasting is greater than the permissible values, the aggregating of such machines/implements is forbidden.

The Expedient loading and stability can be provided by following the recommendation given below:

- Following the recommendations of the Operating Manual for the Tractor.

- Using the recommended standard size of the tyres only.

- Inflating the tyres to the pressure values necessitated by the tractor axle loads, jobs to be performed, and soil and weather conditions. The recommended tyre inflation pressures for the tractors with due account of actual loads can be found in Tyre Load-Capacity Table (Table 7-21). The tyre capacity decreases as the speed in-creases and the inflation pressure in tyres decreases.

- Maintaining the adequate speed when performing the field and transportation works.

- Combining the aggregating methods (working with the front and rear hitch linkages used at the same time) and ballasting.

- The total maximum weight of the tractor which falls on the front and rear wheels of the tractor should not exceed 9000 kg, with due observance of allowable axle loads.

5.9 RECOMMENDATIONS FOR IMPROVING THE GRIPPING-AND-TRACTION PROPERTIES OF THE TRACTOR AND SATISFYING THE STEERABILITY CRITERION

The tractor design provides for possible variation of the tractor operating weight and improvement of gripping and traction properties by way of tire ballasting and twinning of wheels as follows:

•Twinning of the front and rear wheels of the tractor.

•Filling the tyre tubes of tractor wheels with liquid.

•Using the standard (front) ballast and optional ballast (counterweights) to be installed on the rear or front hitch coupler.

Twinning the wheels makes it possible to reduce substantially the specific pressure on the ground and to preserve the soil structure, especially that of wetted fields. Twinning the wheels on dense soils makes it possible to improve the gripping and traction characteristics of the tractor, especially in conjunction with correct choice of the combination method: the values of the load and ballasting should not exceed the permissible values.

ATTENTION!

•For highly efficient employment of the tractor on jobs of different kinds, in a wide range of traction, it is necessary to follow recommendations on loading duties (see Table 7-20).

•Additional loading of the wheels by filling liquid (solution) into the tyre tubes of the tractor should be **only used in case of insufficient tyre grip with the soil under adverse conditions** (water-logged ground, etc.). If tyre gripping is satisfactory, filling the tyre tubes with liquid is not recommended, as it results in overload of the transmission and working equipment attached to the tractor.

•The tyres filled with liquid impair the smoothness of tractor running at speeds exceeding 20 km/h (transportation works).

ATTENTION! NEVER fill in the tyre tubes to their full volume, because it can result in the tyre carcass break in case of running over an obstacle on the road.

5.10 Allowable Loads on the Tractor Tyres Depending on the Pressure in the Tyres

Tyre	Load index	Speed symbol	Speed, km/h	Load per tyre, kg, at the internal pressure, kPa						
				60	80	100	120	140	160	180/200
420/70R24	130	A8	10	1700	1875	2050	2230	2405	2585	
			20	1535	1720	1845	2030	2210	2335	2850
			30	1340	1500	1605	1765	1925	2035	(190кПа)/-
			40	1250	1400	1500	1650	1800	1900	
520/70R38	150	A8	10	2485	2940	3350	3725	4080	4410	4710/-
			20	2250	2660	3035	3370	3690	3990	4275/-
			30	2020	2390	2725	3030	3315	3585	3830/-
			40	-	-	2545	2830	3100	3350	3600/-
18.4R38	146	A8	10		2925	3240	3555	3870	4185	4710/5025
			20	2395	2655	2915	3170	3430	3690	4275/-
			30	2085	2310	2535	2760	2985	3210	3830/-
			40	1950	2160	2370	2580	2790	3000	3600/-

1.The pressure shall be set in the “cold” tyres.
2.When performing the works requiring large traction forces on the hook, set the pressure as for the speed of 30 km/h. When performing the transportation works on the roads with hard pavement, increase the pressure by 30 kPa.

5.11 SELECTING THE MACHINES TO BE AGGREGATED WITH THE TRACTOR

A great number of various technical facilities intended for agricultural tractors are now in service. These machines offer different technical characteristics which are defined by the type and conditions of jobs they are intended for.

The Operation and Service Manual provides for the information on the tractor design, capabilities of the working equipment designed to be aggregated with the tractor, load duties and regulations for safe operation of the tractor that makes it possible to select and aggregate the machines correctly. In any case, the recommendation given by the Manufacturer cannot be all-inclusive for all the cases of operation of the tractor, because even when the tractor is operated in pair with the same machine, its power parameters as well as impact of the machine and soil on the tractor are substantially different under various operating conditions.

The selection, outfit and employment of the tractor within a MTA based on specific machines are specified by the technical documentation for operation of the machines attached to each machine to be aggregated.

ATTENTION! Prior to aggregating or purchasing the specific machines, make sure that it is capable to operate in combination with a BELARUS tractor by proceeding as follows:

1. If possible, obtain the recommendations from the vendor (manufacturer) of the agricultural machine.
2. Make a thorough study of the Operation Manual for the tractor and machine.
3. Check the compliance as to:

- power consumption;
- load capacity of its mounting devices;
- its mounting dimensions, including the conformance of the PTO and the machine universal driveline co-ordinates;
- critical loads on the HDC, tyres, and tractor axles.

4. Make sure that all the working equipment required for aggregating the machines (PTO tail-piece of necessary standard size, front hitch coupler, reversible operating post, auxiliary spacer-ring piece for tyre twinning, hoses, break-away couplings, etc.) are available. Order or purchase it at extra cost, if required.
5. Check the tractor's capability of moving within the MTA:

- estimate the steerability;
- possibility of running at the speeds required for fulfilling certain jobs;
- off-road capability.

6. Check the possibility of joint operation (in both transport and working position) of the tractor with the machine.

Tractors BELARUS of the models described can be used on almost entire range of farm jobs of general-purpose, in various soil and climatic zones, within a MTA combination based on machines with an average draft resistance of 25...30 kN. The tractors can be aggregated with the machines intended for operation with the tractors having the power exceeding 200 hp (such as BELARUS 2522, K 700 and other tractors of class 4...5) under favourable conditions (soils of normal moisture, with specific resistance of rs < 35 kN/m2). On heavy soils and under adverse climatic conditions, the employment of machines designed for Class 1.4 and 2 tractors is conceivable. These tractors can be used for cultivation of row crops following special agronomic techniques which call for an expanded wheel track to ensure un-obstructed run of the tractor.

The availability of the standard and additional equipment for aggregating makes it possible to use the tractors in agriculture in various combinations for power-consuming applications.

The working width and operating depth of an implement/machine depend basically on the specific resistance of soils which defines the operating speed range with due account of the agricultural requirements. The heavier is the soil, the higher is the unit resistance. Based on the average traction effort of 27...36 kN developed by a Class 3 tractor on a stubble field, a rough estimate of the working width for the main power-consuming agricultural machine coupled to a tractor on average soils has been made.

The results shown make it possible to choose agricultural ma-chines/implements by their working widths

including echelon arrangement obtained by means of coupling devices (harrows, cultivators, seeding machines, etc.). The figures given in Table 7-22 are approximate.

Technical facilities	Unit resistance P for medium soils, kN/m, at a speed of v * = 5 km/h	Feasible working width, m
Share plough	12...14	2,0...2.5
Disk harrows	1.6...2.1	up to 12
Share scufflers	6.0...10.0	3...4
Cultivators	1.6...3.0	up to 10
Sowing machines	1.2...1.8	up to 12
Reaping machines	1.2...1.5	up to 15
Combine harvesters:		
silage harvesters	2.6...3.3	up to 3.0
beet combine	6...12	up to 3.0
potato harvester	10...12	up to 2.7
* A change in speed by 1 km/h results in the augmentation of unit resistance by up to 1%		

5.12 TILLAGE

Tillage is one of the most power-consumptive type of field operations. The BELARUS tractors of these models can be used on medium and large fields with 5…7-bottom share ploughs, depending on soil conditions.

The tractor is used as part of an aggregated tillage combination in line with a “tractor-furrow” pattern. It requires appropriate wheel arrangement when running with common, swivel and turnabout ploughs. Its aggregating with ploughs on “tractor wheel off the furrow” is also possible. In this case, the wheel arrangement pattern problem is less stringent. It is becomes therefore expedient to twin the rear wheel and improve the tractor gripping and traction properties, especially with tyres filled in with liquid.

To obtain smooth tillage, the swivel and two-way ploughs are used. They provide for high-quality tillage, without crown ridges and open furrows. To ensure the trouble-free and continuous operation of the tractor, it is recommended to use the ploughs equipped with automatic protection facilities: after such a facility comes into action and the plough passes over an obstacle, the plough body automatically reverts to its initial position, without interruption of the tillable aggregate operation.

When preparing for tillage, it is necessary to perform the following works:

•Checking and adjusting as necessary the rear hitch linkage.

•Rearrangement of the wheel in accordance with the tillage pattern selected.

•Checking and adjusting the plough in accordance with the directions of its operating manual.

To obtain the best results in ploughing, it is important to choose correctly the type and parameters of the plough. The plough type, cutting width (the number of plough bottoms) depend on the soil, its texture, the degree of contamination with stones and ploughing depth. Approximately, one plough bottom requires the power of 20 kW (on medium soils).

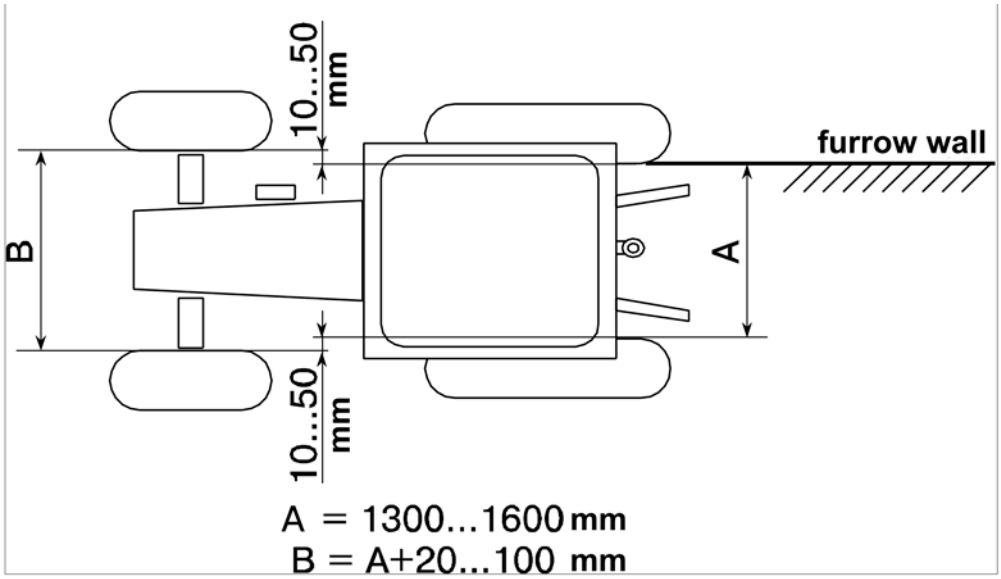
The speed regime of the tillage aggregate should be chosen taking into ac-count the plough bottom type, soil group and climatic conditions, and so that the sufficient traction for overcoming the draft resistance of the plough and intermittent overloads would be achieved.

To maintain a technologically required speed and to obtain ploughing of good quality in case of aggravated soil and climatic conditions, it is a good practice to reduce the working width of the plough by removing the last bottom or in any other manner, if this operation is provided for by the plough design.

In case of ploughing of wet soils and on slopes following a “tractor wheels off the furrow” pattern, the slipping down into the open furrow is possible. In such cases it is preferable to plough using a “tractor-wheel-in-furrow” pattern, with reduced working width.

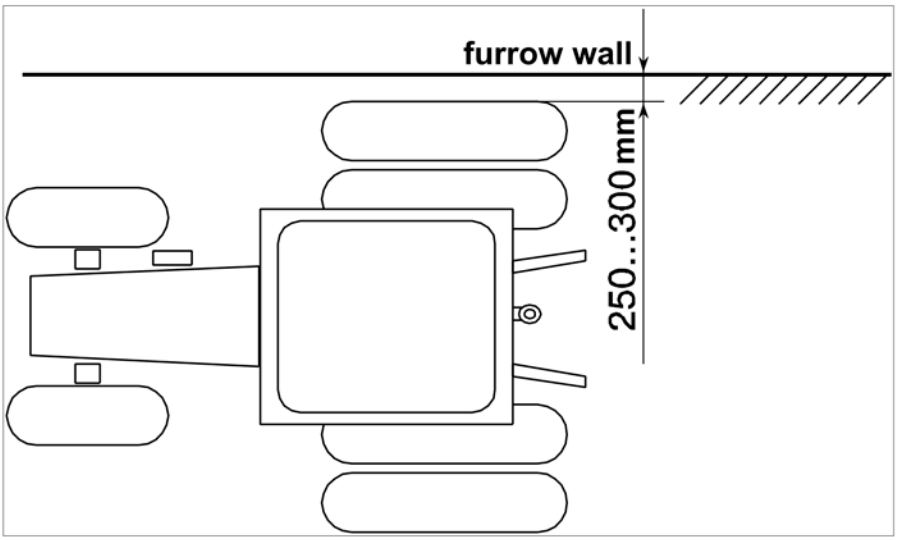
5.13 Diagram of Wheel Arrangement for Aggregating the Tractor with 5...7-Furrow Ploughs

The tractor wheels are in the furrow



To obtain the wheel track figure, it is necessary to add the cross section of a respective tyre to the dimensions A and B.

The tractor wheels are out of the furrow.



The rear wheel track is in accordance with the twinning pattern.

5.14 DRIVING THE TRACTOR ON PUBLIC ROADS

For as much as half of their operating time, tractors are used on public roads, including the hauling of agricultural ma-chines in the transport position. All the vehicles intended for running on public roads shall meet more stringent safety requirements. In this case, the tractor and the machine/implement attached, trailed by or mounted thereon shall com-ply with the requirements for competent operation and maintenance. The tractor owner and/or operator are responsible for observance of the officially adopted traffic regulations and technical requirements imposed on road transport.

The vehicles whose width exceeds the tractor overall dimensions shall be equipped with cat's eyes.

Special permits and particular regulations are applied for driving the tractors whose overall dimensions with or without machine or implement including loaded or unloaded trailers and semi-trailers exceed at least one of the following dimensions on the public roads:

1. Height: 4 m from the road surface.

2. Width: 2.55 m.

3. Length: 20 m for tractors within a road train.

4. If the load projects beyond the vehicle clearance limits by 2 m or more.

Any departure from the above-listed normative figures is subject to agreement with the authorities responsible for road traffic.

IT IS PROHIBITED TO:

- Articulate the machines, transportation of loads with the weight and/or load distribution between the axles or tyres exceeding the values set forth in the Operating Manual for the tractor.

- Use trailed- and semitrailed-type agricultural machines including general-purpose trailers and semi-trailers, with no safety cables (chains) installed. One of unoccupied holes of the hitch linkage serves for attaching the safety chains (cables) (the mounting hard-ware shall be included in the scope of delivery of the machine to be aggregated).

- Use trailed and semi-trailed machines including trailers and semi-trailers of general- and special-purpose without service and parking brakes.

- Use a haul-and-draw coupling arrangement ТСУ-1 (crossbar) for transporting the technical facilities except in case of jobs to be performed in combination with agricultural machines in the field.

- Drive the tractor on roads of any type whatsoever including railroad crossings, if the machine(s)/implement(s) attached are not in transport position.

- Driving through railroad crossings of electrified sections without a special permit, if the outside dimensions exceeding the 4-m height limit.

- Driving the tractor backward (in reverse) on public roads, since the light-signalling equipment is only designed for the forward travel.

- Haul the attached agricultural ma-chines with process cargo.

General-purpose vehicles should be attached through the ТСУ-2 or ТСУ-3 hitch couplers. The vehicles based on trailers and semi-trailers shall have a sign of maximum permissible speed limit at the rear or on the left side of the machine. The tractor wheel-track would rather be coordinated with that of the trailer (semi-trailer).

Aggregating the tractor in a road train (i.e. tractor + semi-trailer + trailer) is only permitted on dry hard-surface roads with the grades of up to 4%.
To connect signaling equipment of vehicles to be used in combination with the tractor, the tractor is provided with a 7-pin socket for supplying the instruments of the attached vehicle with electric power.
The service brake drive is a one-line circuit and is operated from the tractor operator's seat. The parking brake drive controls shall be fitted on the machine to be attached.

5.15 SELECTING THE TRACTOR SPEED

Job to be done	Tractor outfit	Speed, km/h, max.	Wheel track	Remarks
Operation on slopes		**10**	The wheel track shall correspond to the jobs to be done and correlate with the overall dimensions of the attached technical facilities: to be not less than the wheel track of the trailer (semi-trailer) attached. The wheel track recommended for transport missions – **1800** mm	Increase of the wheel track for improving the stability
Sharp MTA turns		**10**		
Running the MTA to operation site (excl. transport vehicles)		**20**		On public roads
MTA moving (from field to field)	Tyres filled with solution. Twinned tyres	**20**		Without entering public roads
Hauling missions	ТСУ-2В, ТСУ-3К, ТСУ-1М-01	**30**		On public roads

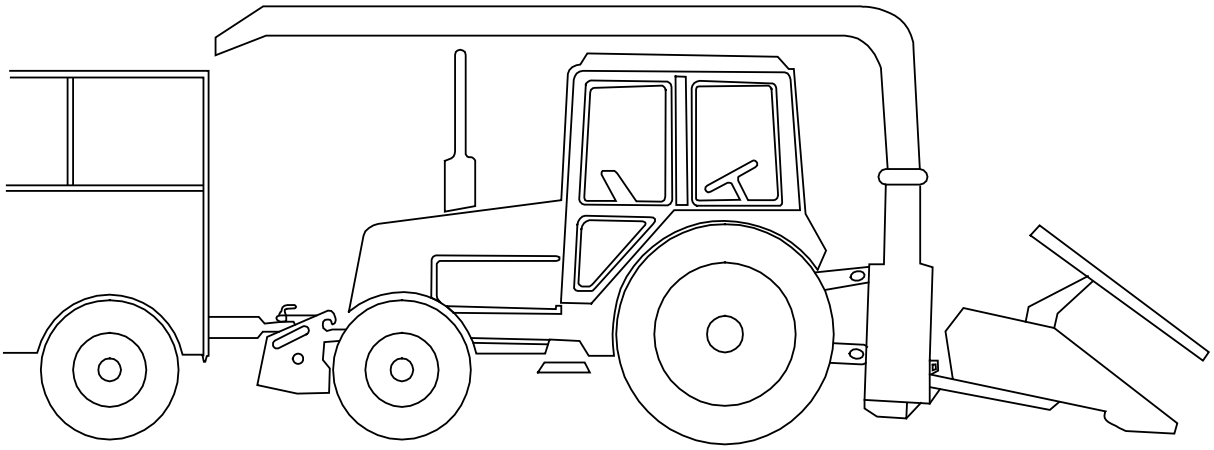
ATTENTION!

When selecting the tractor speed, the operator shall take into account the traffic density, features and conditions of the machines mounted or trailed and cargo to be transported; road and meteorological conditions as well as allow for tractor capacities, with due account of restrictions imposed by the traffic regulations and/or technological requirements of the job to be done. To ensure the road safety, the operator must take measures and be ready to speed down or stop in front of any obstacle.

The travel speed can be limited by the features of the aggregated machine, in conformity with the sign marked on the technical facility.

It is allowed the work of tractor across the slope up to 9° only at the daytime at a speed no more than 10 km|h on the track at least 1950 mm.

5.16 RUNNING THE TRACTOR IN REVERSE



When performing a number of missions (forage harvesting, sugar beet harvest-ing, etc.) the MTA has to run on a stubble field. In this case, driving the tractor backwards for performing the required technological operations pays the additional expenses. Mounted or semi-mounted machines are usually employed for such jobs (reapers. combine harvesters and the like). A harvesting train may include a trailer for receiving the minced matter in bulk to be attached through a front hauling device, including the mounted counterweights or through a crossbar installed at the mounting axis of the НУ-2 front hitch arrangement. The readjustment for reversible operation and conversely takes 3…4 minutes.