PROFILOGRAMS OF SHARE-MOULDBOARDS SURFACES
OF SOME TYPICAL PLOUGH BODIES
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Abstract. Studies have been carried out to determine the design and the share-mouldboard parameters of some contemporary plough bodies: the cultural (digger), semi-helicoidal and helicoidal types. For this purpose the profilograms of share-mouldboard surfaces are made and the values of the investigated parameters measured. The main parameters of the plough body that determine the ploughing efficiency are the initial and the final soil slice lifting angles on the share-mouldboard surface, the angle of its horizontal generatrix, the radius of this surface and the working width of the body. The energetic, agronomic and economic characteristics of ploughs were estimated by testing. As the result of the investigations it was discovered that the optimal values of the main parameters of the bottoms for contemporary ploughs are: the inclination angle of the share towards the furrow bottom – 28…32°, the inclination angle of the horizontal generatrix towards the furrow wall on the initial part of the share-mouldboard surface – 34…38°, on the top – not less than 48°; the working width of the bottom – 45…50 cm. The use of the bodies having optimal parameters allows attaining good ploughing quality, reducing draft resistance by 12…20 % and raising correspondingly the efficiency, saving fuel and financial resources for ploughing.

Keywords: ploughs body profilograms, optimal parameters, working efficiency.

Introduction
It is known that the draft resistance of ploughs, the energy requirement for ploughing, the quality of ploughing and expenses depend on the plough body design, which is determined by the share-mouldboard parameters and the parameters of its supporting surfaces.

In the Latvian agriculture the transition process from the old machines, made in the former Soviet Union, to new ones coming from the West European countries is going on. The new machinery is more progressive but more complicate and expensive, too. Therefore, measures should be taken to choose and use more efficient machines, including ploughs. At present nobody carries out such assessment of the ploughs in Latvia. The documents about their purchase do not present objective information allowing choosing the most suitable plough for particular circumstances.

The purpose of this investigation was: by taking off profilograms to clarify the design and values of the main parameters of share-mouldboards surfaces of the plough bodies allowing the estimation of their efficiency and suitability for ploughing soil under the Latvian conditions.

Materials and methods
An assessment of some plough bodies, mainly used on Latvian farms, as well as those offered by the plough manufacturers and dealers, was carried out. The profilograms were captured. The design of the plough body and its share-mouldboard surface are defined by its angular and linear parameters (Figure 3), the main of them being as follows.

The angular parameters of share-mouldboard surface:
- initial inclination (lifting) angle – $\varepsilon_1$ (the inclination angle of the share towards the horizontal plane, respectively – towards the furrow bottom);
- final lifting angle – $\varepsilon_2$ (the inclined upper part of the surface);
- inclination angle of the horizontal generatrix – $\gamma$ (the inclination angle of the horizontal shape lines towards the vertical-longitudinal plane, respectively – towards the furrow side) and the regularities of its variation.

The linear parameters of the share-mouldboard surface and the plough bottom:
- working width of the bottom – $b$;
- working width of the plough share – $b_s$;
- radius of the mouldboard curvature – $r$;
- height of the share-mouldboard surface – $h$;
- length of the share-mouldboard surface – \( l_i \) (the length of the projection in the direction of its movement);
- width of the share-mouldboard surface – \( b_i \) (the width of the body profile).

![Diagram of the plough body with its angular parameters](image)

**Fig. 1. Scheme of the plough body with its angular parameters**

**Results and discussion**

Studies were carried out of a series of share-mouldboard surfaces of the plough bodies. The shapes of the share-mouldboard surfaces were determined according to their profile lines, the parameters – by measuring the angles of or the distances between these profile lines. In order to get the profile lines, a special stand (test bench) was used. The profile lines were obtained by cutting the share-mouldboard surface with the planes running in parallel to the coordinate planes x-z, y-z and x-y, as well as with the planes which are vertical to the plane x-y running perpendicularly to the share edge. The distance between the shape lines (the foot-pace) was 25 mm. The values of the share-mouldboards parameters: the inclination angles \( \gamma \) of the horizontal shape lines, the initial \( \varepsilon_1 \) and the final \( \varepsilon_2 \) lifting angles and the radius \( r \) of the mouldboard were determined using the data about the form and location of the shape lines.

Profilograms of some plough bodies, mainly used on Latvian farms or studied, as well as those offered by the plough manufacturers and dealers are presented in Figures 2, and 3.

![Images of plough bodies](image)

**Fig. 2. Types of plough bodies:**
- a – cultural body PLŽ 31.000 of the PLN plough group;
- b – culture-semi-helicoidal body PGC–61.000 (PGC–31.000) of the PGP plough group;
- c – semi-helicoidal body KVU-40000 manufactured for the PGP plough group;
- d – semi-helicoidal body No 8 of the Kverneland plough group;
- e – helicoidal body SA 600 HL of the Overums-Bruk plough group;
- f – culture body P 135-13 of the plough PH-1-422 from Czechy
In Table 1 there are given parameters of the share-mouldboard surfaces of the plough bodies mentioned above. In addition, the parameters are included in the table showing:

- inclination angles of the share points $\gamma_p$;
- difference between the angles: $\Delta\gamma = \gamma_{\text{top}} - \gamma_0$; $\Delta\gamma' = \gamma_0 - \gamma_{\text{min}}$; $\Delta\gamma'' = \gamma_{\text{top}} - \gamma_{\text{min}}$;
- height of the shape line having a minimum inclination angle $h_{\text{min}}$;
- inclination angles of the shape lines of the trash-boards $\gamma_i$;
- difference between the angles: $\Delta\varepsilon = \varepsilon_{i} - \varepsilon_{i}^\prime$; $\Delta\varepsilon_{ii} = \varepsilon_{i} - \varepsilon_{i}''$; $\Delta\varepsilon_{i}'''' = \varepsilon_{i}'' - \varepsilon_{i}^\prime$;
- inclination angle of the share point in a vertical-longitudinal plane $\alpha_{lp}$.
- height of the share-mouldboard surface together with the trash-board – \( h \);
- length of the share-mouldboard surface together with the extended lamina – \( l_a \);
- width of the share-mouldboard surface together with the extended lamina – \( b \);
- the number at index \( \gamma \) shows the height of the horizontal shape lines from the ground.

### Parameters of the plough body share-mouldboard surfaces

<table>
<thead>
<tr>
<th>Symbol of the parameter</th>
<th>Unit of measurement</th>
<th>Designation of the plough (trade name)</th>
<th>Overums Bruk SA 600 HL</th>
<th>Kverneland body No 8</th>
<th>Sampo 3-14L</th>
<th>PH-1-422 P 135-13 Czechy</th>
<th>Optimal value of the parameter</th>
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<td>37</td>
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<td>38 (42)</td>
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<td>36</td>
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<td>45</td>
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<td>27...15</td>
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<td>40...26</td>
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<td>48</td>
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</table>
It is evident from the horizontal projects (Fig. 3) that the bodies Overums Bruk SA 600 HL, Kverneland No 8 and KVU 40.000 have longer and shallower mouldboards than the bodies PGC–61.000 and P 135-13. Their shape lines and the parameters (Fig. 3) show that the share-
mouldboard surface of the body SA 600 HL corresponds to the helicoidal surface, the bottom surfaces of the “Kverneland” No 8 and KVU 40.000 correspond to the semi-helicoidal surface but the share-mouldboard surface of the bottom PGC-61.000 – to the culture-semi-helicoidal surface and the bottom surface of P 135-13 – to the culture body. The parameters of the share-mouldboard surfaces of the first three bodies are closest to the optimal ones (Table 1) when working with the contemporary high-speed tractors [4].

Fig. 4. Semi-helicoidal body KAUR–40 AGS having an adjustable curvature of the mouldboard: a – frontal sight: 1 – point (chisel); 2 – share; 3 – mouldboard; 4 – mouldboard extended lamina; 5 – trash-board (skim coulter); 6 – knife; b – rear sight: 1, 2 – spreaders for support and regulation of the share mouldboard curvature; 3 – foot of body; 4 – mouldboard; 5, 6 – struts.

The semi-helicoidal body KAUR–40 AGS (Figure 4), manufactured by the SIA “AGS” in Cesis, has an adjustable mouldboard curvature, as well as angles of the horizontal shape lines (generatrix). This allows obtaining the best mouldboard form corresponding to the particular working conditions.

The coincidence of the horizontal projection of the bodies (share-mouldboards) takes place in such a way that the tips of the share points coincide (see Fig. 4.). The coincidence for the body KVU 40.000 was more beaked to the left; therefore, the contour of its project is beaked (turned) out of the contours of the other bodies (Fig. 5).

Fig. 5. Coincidence of the horizontal projection of some bodies (share-mouldboards): 1 – helicoidal body SA 600 HL of the Overums-Bruk ploughs; 2 – semi-helicoidal body No 8 of the Kverneland ploughs; 3 – semi-helicoidal body KVU-40000 for the PGP loughs; 4 – culture-semi-helicoidal body PGC–61.000 (PGC–31.000) of the PGP ploughs.

The tests carried out with the ploughs showed that, by their energetic and agronomic indices, the most suitable for the work at the contemporary speeds of 2.5...3 m·s⁻¹ are the plough bodies with helicoidal or semi-helicoidal share-mouldboard surfaces [1; 2; 4].
The optimal values of the main parameters of the bottoms for the contemporary ploughs working at the speeds 2.5–3 m·s⁻¹ are: the inclination angle of the share towards the furrow bottom – 28…32°; the inclination angle of the horizontal generatrix towards the furrow wall on the initial part of the share-mouldboard surface – 34…38°, on the top – not less than 48°; the working width of the bottom – 45…50 cm.

The conducted investigations show that more suitable for the work with the contemporary high-speed tractors are the ploughs which have bodies with gently sloping helicoidal or semi-helicoidal share-mouldboard surfaces.

The suitability of the new ploughs for the Latvian conditions may be assessed by obtaining shape lines and determining the parameters of the share-mouldboards surfaces of the bodies.

**Conclusions**

1. By means of the created test-bench, profilograms (shape lines) were obtained for the share-mouldboard surfaces of some bodies mainly used on the farms of Latvia, as well as their parameters and suitability for the Latvian conditions were determined.

2. The conducted investigations show that more suitable for the work with the contemporary high-speed tractors are the ploughs which have bodies with gently sloping helicoidal or semi-helicoidal share-mouldboard surfaces.

3. The optimal values of the main parameters of the bottoms for the contemporary ploughs working at the speeds 2.5…3 m·s⁻¹ are: the inclination angle of the share towards the furrow bottom – 28…32°; the inclination angle of the horizontal generatrix towards the furrow wall on the initial part of the share-mouldboard surface – 34…38°, on the top – not less than 48°; the working width of the bottom – 45…50 cm.

4. The use of the bodies having optimal parameters allows attaining good ploughing quality, reducing their draft resistance by 12…20 % and raising correspondingly the efficiency, saving fuel and financial resources for ploughing.

5. The suitability of the new ploughs for the Latvian conditions may be assessed by obtaining shape lines and determining the parameters of the share-mouldboards surfaces of the bodies.

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