Substantiation of the Use of a Flexible Chain-Type Subsoiler for Improving the Agrotechnological Properties of Soil

Andriy Kondratiuk 1, Egidijus Šarauskis 2, Bohdan Sheludchenko 1, Savelii Kukharets 1,2,*, Algirdas Jasinskas 2, Pavlo Zabrodskyi 1 and Vladyslav Shubenko 1

1 Department of Mechanics and Agroecosystems Engineering, Polissia National University, Staryi Blvd 7, 10008 Zhytomyr, Ukraine; kondratichov@gmail.com (A.K.); sheludchenkobogdan@ukr.net (B.S.); zabrpm@gmail.com (P.Z.); vlad19ua@gmail.com (V.S.)
2 Department of Agricultural Engineering and Safety, Agriculture Academy, Vytautas Magnus University, Studentu 15A, Akademija, LT-53362 Kaunas, Lithuania; egidijus.sarauskis@vdu.lt (E.S.); algirdas.jasinskas@vdu.lt (A.J.)
* Correspondence: savelii.kukharets@vdu.lt

Abstract: Technogenic influence on agricultural soils leads to the transformation of their morphological features, significantly worsens their agrochemical, physical, mechanical and agrotechnological properties, prevents the optimal use of potential soil fertility and, as a result, leads to a decrease in crop yield. Mechanical soil decompaction when using various types of subsoilers, including the flexible chain-type working body (the chain), is used to prevent the negative consequences of technogenic influence. According to the results of the analytical calculations, the proportionality factor of the chain length, which determines the ratio of the width of the plow grip to the chain length of a flexible subsoiler, was established. The specified coefficient is proportional and equals 2.4. The use of the specified coefficient allows us, at the stage of the development of the design and technological documentation, to determine the main design parameter of the flexible subsoiler, which is the length of the used chain depending on the width of the plow grip. The surface of the field cultivated with the experimental tillage tool meets the requirements for sowing the agricultural crops without performing additional technological operations.

Keywords: soil; technogenic transformation; decompaction; flexible subsoiler; design parameter; chain; machine-tractor unit; plowing

1. Introduction

In order to ensure the sustainable development of agricultural production in the context of increasing anthropogenic pressure on soils, it is necessary to continuously improve the scientific validity of machine designs and the processes they perform [1]. Trends in the development of agricultural systems indicate that plowing with the rotation of the soil layer continues to be the predominant method of main soil cultivation. However, recently, the volume of soil cultivation when using plows, as the basis of ecologically safe technologies, which make it possible to significantly reduce the level of use of chemical fertilizers, has increased. Therefore, the fundamental improvement of soil preparation technologies when using the rotation of soil layers and the creation of corresponding highly effective technical means remains relevant [2].

A significant problem with the agrotechnological nature of soil applied for long-term agricultural use is the formation of “a plow sole” [3] as a result of cyclically repeated technogenic effects on the arable layers of the soil [4–6]. At the same time, the natural morphological characteristics of the soil profile are transformed. As a result, the morphological characteristics of the soil profile acquire irreversible harmful changes. Such transformation of agricultural soils leads to a significant deterioration of their agrochemical, physical,
mechanical and agrotechnological properties [7], preventing the maximum possible use of the potential soil fertility, which causes a decrease in the yield of agricultural crops [8–10].

To a certain extent, it is possible to partially prevent the indicated negative transformation of the morphological features of the soil profile by applying agrotechnological measures that reduce soil compaction [11]. At the same time, the most used and the most effective method of reducing soil compaction is the mechanical destruction of a plow sole [12,13]. In practice, such destruction of soil compaction is realized using various subsoilers, chisels, soil deep loosening machines, etc. [14–16]. It should be noted that the use of the above-mentioned working bodies contributes to an increase in energy costs for tillage. Most of the scientific research is aimed at improving the geometric shape of the working bodies themselves, which does not give a sufficient result in view of the destruction of the plow sole, although it has some effect in terms of creating an agronomically valuable soil structure [17–19]. The scientific research [20] proves that the cultivation units with skimmers, second-row skimmers or other bodies creates an acceptable soil structure and partially destroys plow soles. But the design of such tillage tools is somewhat complicated; in addition, they have a large mass and require additional fuel consumption. However, the use of plows without additional working bodies does not sufficiently ensure the fulfilment of agronomic requirements regarding soil structure.

One of the most promising designs of a subsoiler used as a part of a machine-tractor unit for plowing, with regard to the manufacturability of its design, is the subsoiler that takes the form of a flexible loop of chain, the ends of which are fixed on the additional pillars of the first and last plow bodies (Figure 1), as was well described in a scientific paper [21].

![Figure 1. Plow PLN-5-35, equipped with a flexible subsoiler.](image_url)

The main design parameter of such a subsoiler is the length of the chain used, which is determined by the number of plow bodies, which ultimately determines the width grip of the plow machine-tractor unit. The specified design parameter of the subsoiler must be determined (calculated) for each standard plow size during the stage of developing the design and technological documentation for the plow. In addition, the proposed tillage tool may contribute to the partial or complete destruction of the plow sole and also to the improvement of the soil structure in comparison with traditional (classical) plowing.
aim of the work was therefore (a) to find mathematical dependencies that would allow us to determine the rational length of a flexible subsoiler and (b) to carry out relevant comparative experimental research in the field.

2. Materials and Methods

The purpose of the experimental research was to determine the mechanical properties of the soil (coefficient of structurality, hardness and density of the soil) and indicators of the quality of the soil cultivation (unevenness of the relief of the field surface) after cultivation with the PLN-5-35 (VELES AGRO, Ukraine, Odessa) [22] plow, which was equipped with a flexible subsoiler (chain) (Figure 2), in comparison with a basic implement—plow PLN-5-35 without a chain.

![Experimental tillage tool on the base of a five-body plow.](image)

During the experimental studies, a steel chain, 4.2 m long and 3 kg in weight, was used. The chain dimensions were selected according to DIN5685. A schematic image of the chain is shown in Figure 3.

![Geometric dimensions of chain links.](image)

According to the stated purpose, the program of the research provided for the determination of the main indicators of the quality of soil cultivation: the structurality coefficient, soil hardness, soil density, soil moisture and unevenness of the relief of the field surface. Soil tillage quality indicators were determined in three ways:

1. The main control—cereal stubble.
2. Conventional tillage of soil cultivation with a plow PLN-5-35 without a chain.
3. Compared variant of tillage with a PLN-5-35 plow equipped with a flexible sub-soiler (chain).

The soil in question was a sandy loam soil (called Calc(ar)i—Endohypoglevic Luvisol, according to the 4th edition of the international soil classification system [23]). The period of research was March to April. The soil selection procedure was as follows: the area on which the research was conducted (0.2 ha for each variant of the experiment) was divided into 10 plots. At least 3 samples were taken in each plot. Thus, the total number of samples was 30 for each experiment. Soil samples were taken from a depth of 5–20 cm. A steel soil probe sampler was used for soil sampling. To determine the absolute soil moisture, additional samples were taken the next day (after 24 h), and the sampling depth was 10–20 cm. The soil samples were dried in a thermostat (at a temperature of 100–105 °C) to a constant weight. The weight of the sample after completion of the drying process was compared with the weight of the sample before drying, and an absolute final moisture content or a value relative (percent) to the original sample weight was obtained.

The indicators of the structural state of the soil were established by the coefficient of structurality \( K_s \):

\[
K_s = \frac{A}{B},
\]

where

- \( A \)—the mass of soil aggregates with a size of 0.25–10.0 mm, kg;
- \( B \)—the mass of soil aggregates with a size of <0.25 mm (soil dust) and soil aggregates with a size of >10 mm, kg.

The values of \( A \) and \( B \) were determined by the method of fractionation of soil samples in the air-dry state on the special installation shown in Figure 4, by division into fractions: >10; 10–7; 7–5; 5–3; 3–2; 2–1; 1–0.5; 0.5–0.25; <0.25 mm. That is, analysis of the content of aggregates of various diameters was performed. The distribution of the soil into aggregates took place thanks to the vibration of special sieves; the vibration frequency of 0.75 Hz was provided by a special installation.

![Figure 4. Installation for analysis of the content of aggregates of various diameters of the soil: 1—grate set; 2—electric motor; 3—platform; 4—flywheel; 5—cam mechanism.](image)

With the help of Penetrologger Royal Eijkelkamp (Royal Eijkelkamp, Giesbeek, The Netherlands) [24], soil hardness \( P \) and the coefficient of volume shrinkage \( q \) were determined as

\[
q = \frac{F}{V},
\]

where

- \( F \)—the resistance of the soil, which corresponds to the limit of proportionality, N;
• $V$—the volume of the compacted soil that corresponds to the limit of proportionality, cm³.

Sampling to determine the condition of the soil was carried out with the help of the field laboratory devices.

Absolute soil moisture $W$ of the soil was determined by the following formula:

$$W = \frac{W_1 - W_2}{W_2} \cdot 100\%,$$

(3)

where

• $W_1$—weight of moist soil, g;
• $W_2$—weight of the dry particles, g.

The soil bulk density was determined by the following formula:

$$D = \frac{M}{V},$$

(4)

where

• $M$—the mass of a completely dry sediment in a certain volume of the investigated sample, g;
• $V$—the volume of the studied sample, cm³.

The determination of the unevenness of the surface of the cultivated soil and the bottom of the furrow was carried out using a coordinate rail by the method of graphic copying of the relief.

3. Theoretical Results: Modeling of Chain Length

As an analytical model of the length $L$ of a chain of a subsoiler (as “a chain line of a loop of a flexible thread”), a certain parabola in the horizontal plane was determined X–Y:

$$y = f(x)$$

(Figure 5).

![Figure 5. Analytical model of a “flexible thread” loop of a subsoiler.](image)

The design length $L$ of a chain of a subsoiler, as “a chain line of a loop of a flexible thread”, was determined (the integration limits $a$-$b$ are defined by the length of the parabola section from point $A$ to point $B$) as

$$L = \int_{a}^{b} \sqrt{1 + (f(x))^2} \, dx$$

(5)
For the considered model, \( y = f(x) = x^2 \) after transformation of Equation (5) (we limit the length of the “chain line of the flexible thread loop” of the subsoiler to the right branch of the parabola), so the following equation was obtained:

\[
L = \int_0^2 \sqrt{1 + (f(x))^2} \, dx = \int_0^2 \sqrt{1 + (2x)^2} \, dx = \int_0^2 \sqrt{1 + 4x^2} \, dx
\]

(6)

To calculate the integral (6), the subintegral function was multiplied and divided by \( \sqrt{1 + 4x^2} \). As a result, the following was obtained:

\[
L = \int_0^2 \sqrt{1 + 4x^2} \, dx = \frac{1}{2} \int_0^2 \frac{2dx}{\sqrt{1 + (2x)^2}} + 4 \int_0^2 \sqrt{1 + 4x^2} \, dx = \frac{1}{2} \int_0^2 \frac{2dx}{\sqrt{1 + (2x)^2}} + 4 \int_0^2 dx
\]

(7)

For further calculations of the right-hand side of Equation (7), the first integral was reduced to a tabular form, and the formula for integration by parts was applied to the second integral:

\[
\int_0^2 \frac{dx}{\sqrt{1 + 4x^2}} + 4 \int_0^2 \sqrt{1 + 4x^2} \, dx = \frac{1}{2} \left[ \ln \left( \frac{x + \sqrt{1 + 4x^2}}{2} \right) \right]_0^2 - \frac{1}{4} \ln \left( \frac{x + \sqrt{1 + 4x^2}}{2} \right)_0^2 - \frac{2}{4} \ln \left( \frac{x + \sqrt{1 + 4x^2}}{2} \right)_0^2 - \frac{1}{4} \ln \left( \frac{x + \sqrt{1 + 4x^2}}{2} \right)_0^2 + 2 \sqrt{1 + 4x^2} - \frac{1}{4} \ln \left( \frac{x + \sqrt{1 + 4x^2}}{2} \right)_0^2 - \frac{2}{4} \ln \left( \frac{x + \sqrt{1 + 4x^2}}{2} \right)_0^2
\]

(8)

Thus, the following was obtained:

\[
\int_0^2 \sqrt{1 + 4x^2} \, dx = \frac{1}{2} \ln \left( \frac{4 + \sqrt{17}}{2} \right) + 2 \sqrt{17} - \frac{1}{4} \ln \left( \frac{4 + \sqrt{17}}{2} \right)_0^2 - \frac{2}{4} \ln \left( \frac{4 + \sqrt{17}}{2} \right)_0^2
\]

(9)

Equation (5) was solved with the assumption that the sought integral \( \int_0^2 \sqrt{1 + 4x^2} \, dx \) was unknown. As such,

\[
2 \cdot \int_0^2 \sqrt{1 + 4x^2} \, dx = \frac{1}{2} \ln \left( 4 + \sqrt{17} \right) + 2 \sqrt{17}
\]

(10)
or

\[ L = \int_0^2 \sqrt{1 + 4x^2} \, dx = \left( \frac{1}{4} \ln \left(4 + \sqrt{17}\right) + 2\sqrt{17} \right) \text{ (lin. un.)} \]  

(11)

From these equations, it was determined that \( L = 4.62 \text{ (lin. un.)} \)

\[ L = 4.62 \text{ (lin. un.)} \]  

(12)

According to Figure 5, conventional linear units were determined using the design and operational parameters of the tillage tool. Thus, for the PLN-35 (Figure 1) plow, the three linear units equaled

\[ 2(\text{lin. un.}) = a \cdot (n - 1) \]  

(13)

where

- \( a = 0.35 \text{ (M)—grip width of the plow body;} \)
- \( n—\text{the number of plow bodies in the tillage tool.}\)

Based on the above, the calculated minimal total length of the flexible subsoiler for plow PLN-35 equaled

\[ L = 4.62 \cdot \frac{1}{2} \left[ a \cdot (n - 1) + a \right] = 4.62 \cdot \frac{1}{2} \left[ 0.35 \cdot (5 - 1) + 0.35 \right] = 4.0425 \text{ (m)} \]  

(14)

Table 1 shows the values of the design length of the flexible subsoiler for a line of plows: PLN-3-35, PLN-4-35, PLN-5-35, PLN-6-35, PLN-8-40 and PLN-9-35.

Table 1. Design length of the flexible subsoiler.

<table>
<thead>
<tr>
<th>Plow Brand</th>
<th>Plow Image</th>
<th>Analog</th>
<th>Calculated</th>
<th>Chosen</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLN-3-35</td>
<td>Gregori Besson Prima 50-3+ [25]</td>
<td>2.4255</td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td>PLN-4-35</td>
<td>Sukov JUNIOR ROTO 3+1 [26]</td>
<td>3.2340</td>
<td>3.4</td>
<td></td>
</tr>
<tr>
<td>PLN-5-35</td>
<td>Lemken Juwel 10 M 5 90 [27]</td>
<td>4.0425</td>
<td>4.2</td>
<td></td>
</tr>
<tr>
<td>PLN-6-35</td>
<td>Kverneland ED—LD 5 [28]</td>
<td>4.8510</td>
<td>5.0</td>
<td></td>
</tr>
</tbody>
</table>
The analysis of the data in Table 1 shows the consistency of the ratio of the length of the flexible subsoiler to the design width of the plow grip (Table 2).

Table 2. The ratio of the width of the plow grip to the length of the chain of the flexible subsoiler.

<table>
<thead>
<tr>
<th>Plow Brand</th>
<th>Brand</th>
<th>Analog</th>
<th>Calculated</th>
<th>Chosen</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLN-8-40</td>
<td>Gregori Besson Voyager S60 [29]</td>
<td>7.3920</td>
<td>7.6</td>
<td></td>
</tr>
<tr>
<td>PLN-9-35</td>
<td>Gregori Besson Voyager S70 [29]</td>
<td>7.2765</td>
<td>7.5</td>
<td></td>
</tr>
</tbody>
</table>

* The universal value of the coefficient, which determines the ratio of the width of the plow grip to the length of the chain of the flexible subsoiler, is $K = 2.39 \approx 2.4$.

Thus, the analysis of the calculated data given in Table 2 allows us to establish the universal value of the coefficient $K$, which determines the ratio of the width of the plow grip to the length of the chain of the flexible subsoiler, as $K = 2.4$. The specified coefficient can be used as a certain design parameter in the design of new promising samples of tillage tools.

4. Results of the Comparative Field Tests

The average values of the obtained results of the comparative field tests are shown in Table 3.

Table 3. The results of the comparative tests.

<table>
<thead>
<tr>
<th>Soil Tillage Quality Indicators</th>
<th>Cereal Stubble</th>
<th>Conventional Tilling</th>
<th>Experimental Tilling</th>
</tr>
</thead>
<tbody>
<tr>
<td>The value of the structurality coefficient $K_s$</td>
<td>$0.95 \pm 0.23$</td>
<td>$1.50 \pm 0.23$</td>
<td>$1.70 \pm 0.23$</td>
</tr>
<tr>
<td>The value of soil compaction resistance (hardness) $P_c$, kN/m$^2$</td>
<td>$87.6 \pm 3.3$</td>
<td>$59.2 \pm 3.3$</td>
<td>$50.0 \pm 3.3$</td>
</tr>
<tr>
<td>The size of the volumetric compaction of soil $q$, MPa</td>
<td>$1.4 \pm 0.05$</td>
<td>$0.7 \pm 0.05$</td>
<td>$0.7 \pm 0.05$</td>
</tr>
<tr>
<td>Absolute soil moisture $W$, %</td>
<td>$22.0 \pm 2.1$</td>
<td>$18.3 \pm 2.1$</td>
<td>$18.4 \pm 2.1$</td>
</tr>
<tr>
<td>Soil bulk density $D$, g/cm$^3$</td>
<td>$1.90 \pm 0.09$</td>
<td>$1.31 \pm 0.09$</td>
<td>$1.20 \pm 0.09$</td>
</tr>
<tr>
<td>Microrelief of the field surface, cm</td>
<td>-</td>
<td>0–5.6</td>
<td>0–3.6</td>
</tr>
</tbody>
</table>
According to the results of the study of the structural and aggregate composition of the soil, it was established that the number of soil aggregates (d < 0.25 mm and d > 10 mm, which do not meet the agricultural requirements from the point of view of the erosion resistance) in the experimental tillage decreased by 28.2% compared to the cereal stubble and by 7.1% compared to the base variant, and the structurality coefficient, compared to the base variant, increased by 13.0%. The structurality coefficient was calculated using Formula (11).

The absolute soil moisture in the 10–20 cm layer, when using tillage tools, meets the agricultural requirements [30,31]. The density of the soil tillage meets the agricultural requirements and is 1.20 g/cm$^3$, which is 6.2% less than the conventional tillage and 36.8% less than the cereal stubble. It was established that when working with the soil tillage unit, the value of the resistance to soil compaction was the lowest and equaled 50.0 kN/m$^2$, which was 15.7% less than the conventional tillage and 43.1% less than the cereal stubble (Figure 6). This may indicate partial destruction of the plow sole. The coefficient of the volumetric compaction of the experimental tillage was 51.4% lower when compared to the cereal stubble and the standard value, which was within 1–2 N/cm$^3$ (for a plowed field).

The average height of field unevenness decreased by 1.6 times and amounted to 3.6 cm (Figure 7).

The surface of the field cultivated with the experimental tilling tools meets the requirements for sowing agricultural crops without performing additional technological operations (Figure 8).
Sustainable restoration of agrotechnical characteristics of the soil is possible in several ways [32]. One of these methods is a natural way, where the soil is regenerated through freezing/thawing cycles, shrinkage/swelling or by means of biological loosening when using crops that have a tap root system, such as spring and winter canola and other crops that have a powerful root system. But the natural method of restoring soil characteristics may not always be effective. So, for example, in conditions of global warming, temperatures may not be low enough for freezing/thawing. Another method of restoring soil characteristics is mechanical. If soil compaction is observed below a depth of 20 cm, deep tillage may be required [33,34]. There is a variety of deep tillage equipment options, including parabolic cultivators, disc cultivators [35] for conventional tillage systems and specialty plows or deep tillage may be required [33,34]. There is a variety of deep tillage equipment options, including parabolic cultivators, disc cultivators [35] for conventional tillage systems and specialty plows or

5. Discussion

Scientific publications [7–9] indicate that the main drawback of intensive tillage is soil compaction. Compaction negatively affects the physical properties of the soil and reduces yields. The authors write that the negative effects of soil compaction can be mitigated by replacing conventional tillage with simplified tillage methods. Our own research shows that soil compaction can be reduced by using the flexible working tool (chain) proposed in this scientific article. In addition, the destruction of soil structure during intensive tillage is of great concern [11], and it is believed that the use of the experimental tillage may allow soil structure to be preserved, but this statement requires further thorough research.

Sustainable restoration of agrotechnical characteristics of the soil is possible in several ways [32]. One of these methods is a natural way, where the soil is regenerated through freezing/thawing cycles, shrinkage/swelling or by means of biological loosening when using crops that have a tap root system, such as spring and winter canola and other crops that have a powerful root system. But the natural method of restoring soil characteristics may not always be effective. So, for example, in conditions of global warming, temperatures may not be low enough for freezing/thawing. Another method of restoring soil characteristics is mechanical. If soil compaction is observed below a depth of 20 cm, deep tillage may be required [33,34]. There is a variety of deep tillage equipment options, including parabolic cultivators, disc cultivators [35] for conventional tillage systems and specialty plows or
straight-post cultivators designed for minimally invasive cultivation [1]. It is also necessary to consider no-till technology, which helps to preserve the structure of the soil, restore the microflora in the soil and preserve moisture. However, no-till technology should be used with caution on soils with a low humus content [36,37].

Our research shows that one of the most technological tools for loosening is a good deepener in the form of a flexible chain loop, the ends of which are fixed on additional poles of the first and last plow bodies.

The adoption of experimental tillage by the authors promises to streamline soil preparation processes for agricultural cropping, thereby reducing the number of technological operations required. This advancement is poised to have a significant positive impact on the environment, specifically by mitigating harmful emissions, minimizing soil compaction and preserving soil structure. By decreasing the number of passes and manipulations needed to ready the soil for planting, this innovative tool has the potential to contribute to sustainable agricultural practices and environmental stewardship. This shift towards more efficient soil management techniques not only enhances productivity but also aligns with broader goals of reducing agriculture’s ecological footprint. Therefore, the purpose of our further research will be to determine the amount of reduction in the harmful impact on the environment in the process of using the experimental tillage. In addition, we plan to investigate how the parameters of the chain link on the corresponding plow affect the soil cultivation process. We also plan to more carefully examine the position of the chain in the ground. But the clarification of these characteristics can affect the results of the tillage tool.

6. Conclusions

It was established that the analytically calculated values of the design length of the flexible subsoiler chain as a part of a machine-tractor unit for plowing are proportionally related to the width of the plow grip and are determined in direct proportion with a proportionality factor of 2.4. The use of the proportionality coefficient, which determines the chain ratio of the width grip of the plow to the length of the chain of the flexible subsoiler, allows us to determine the length of the chain during the development of the design and technological documentation, as a defining design parameter that provides optimal conditions for the operation of the soil tillage tool.

It was established that the number of soil aggregates (d < 0.25 mm and d > 10 mm) that do not meet the agricultural requirements from the point of view of the erosion resistance in the experimental tillage decreased by 28.2% compared to the cereal stubble and by 7.1% compared to the base variant, and the structurality coefficient, compared to the base variant, increased by 13.0%. It was established that when working with the experimental tillage unit, the value of resistance to soil compaction was the lowest and equaled 50.0 kN/m², which was 15.7% less than the conventional tillage and 43.1% less than the cereal stubble. This may indicate partial destruction of the plow sole.

The analysis of the quality indicators of soil cultivation obtained from the results of the experiment made it possible to make a conclusion about the positive influence of a plow with a chain on the structural and agrotechnological condition of the soil compared to a standard plow. The surface of the field cultivated with the experimental tillage meets the requirements for sowing the agricultural crops without performing additional technological operations.


Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.
**Informed Consent Statement:** Not applicable.

**Data Availability Statement:** The data presented in this study are available on request from the corresponding author.

**Conflicts of Interest:** The authors declare no conflicts of interest.

**References**


34. Xiao, Q.; Zhao, W.; Ju, C.; Peng, K.; Yuan, M.; Tan, Q.; He, R.; Huang, M. Effects of Different Tillage Depths on Soil Physical Properties and the Growth and Yield of Tobacco in the Mountainous Chongqing Region of China. *Agriculture* 2024, 14, 276. [CrossRef]


Disclaimer/Publisher’s Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.