



Bucking App - A mobile device based application for value-optimized motor-manual bucking

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1 Publishable summary

When timber is harvested, trees are felled and cut (“bucked”) into pieces (so called “assortments”) of different length. Pricing of the assortments depends on their length, diameter class and quality and is given in € per m³, which is then multiplied with the respective volume. In motor-manual felling and bucking operations, the chainsaw operator has to determine which assortments to cut from a given tree. By separating the tree into the most suitable combination of assortments, the highest value can be gained from a given tree. In contrast to fully mechanized harvesting operations, chainsaw operators are at the moment not aided by computers when taking this value-defining decision. Further, they are lacking a proper performance documentation in the form of an assortment list and aggregated volumes per assortment, species, quality, length or diameter class.

The Bucking App is an application for Android OS mobile devices, which aims to close this gap. With the Bucking App, a value-optimized bucking scheme can be determined for a given tree from tree and contractual parameters entered by the user, thereby assisting the chainsaw operator in this critical decision. Further, the Bucking App provides after-operation statistics, which can be utilized for documentation and planning purposes.

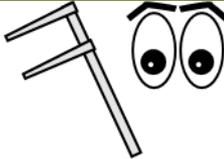
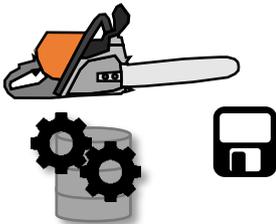
However, the Bucking App does not aim to replace, but to assist the human brain when taking the bucking decision. While on the one hand enabling fully computer-aided operation, the user is on the other hand able to select a customized bucking scheme, which can be compared to the value-optimized scheme. This functionality aims at providing the user with a training option, which can be employed for both personal and institutionalized education and training purposes. This functionality is of further use when defects that go unnoticed during the visual pre-bucking inspection require to alter the original bucking scheme.

The Bucking App’s target groups are (1) only occasionally bucking users (“farmer”), (2) users in education and training (forestry schools and training centres) and (3) professional chainsaw operators. The intention of the app is to not make the user depending on it to take the bucking decision, but to aid the decision as long as the user is not skilled enough to take the decision on his own. Occasionally bucking users are envisioned to profit from the app by assisted training on the job and increases value recovery due to a well-founded decision. In education and training, the app can be used as a tool to compare trainees’ ideas of the most suitable bucking scheme to each other or during personal training to the suggested value-optimized scheme. Professional users can benefit from the Bucking App in terms of work documentation and as calibration tool, where every now and then the user decision is compared against the suggested solution.

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2 How to work with the Bucking App

The Bucking App can be operated in six steps as displayed in Fig 1:

<p>Step 1</p>	<p>Before any operation, the permissible assortments according to the user's contract must be defined. This is done on a computer via a Microsoft-Excel spreadsheet solution. From the spreadsheet, a definition export file is generated and transferred to the mobile device, on which the Bucking App is operated. Multiple definitions can be created. In the app, a new operation is created and operational parameters (e.g. topping diameter, permissible assortment definition, ...) are defined/selected. Multiple operations can be defined.</p>	
<p>Step 2</p>	<p>After selecting an operation, working with the Bucking App in the forest can start. In a first step the tree species is assessed visually and the DBH is measured on the standing tree. Respective data is entered in the app's Tree parameter form.</p>	
<p>Step 3</p>	<p>After felling of the tree, stump height, trunk and crown length are measured and entered in the app's Tree parameter form.</p>	
<p>Step 4</p>	<p>Then the quality allocation along the stem in terms of quality and length of the single quality sections have to be specified and entered in the app's Quality allocation form.</p>	
<p>Step 5</p>	<p>After all data is entered, bucking optimization is carried out and the user receives a value-optimized bucking scheme according to his assortment definition and tree data. If he wishes to customized a scheme, a respective option including comparison to the suggested scheme is available. From here the user proceeds to a visualization of the chosen bucking scheme and the tree can be bucked accordingly. During this step, if necessary, the scheme can be customized again, e.g. because of defects before not recognizable. After completing bucking, tree and assortment data is saved.</p>	
<p>Step 6</p>	<p>After an operation, the user can access tree by tree and cumulated assortment statistics and export data to other electronic devices.</p>	

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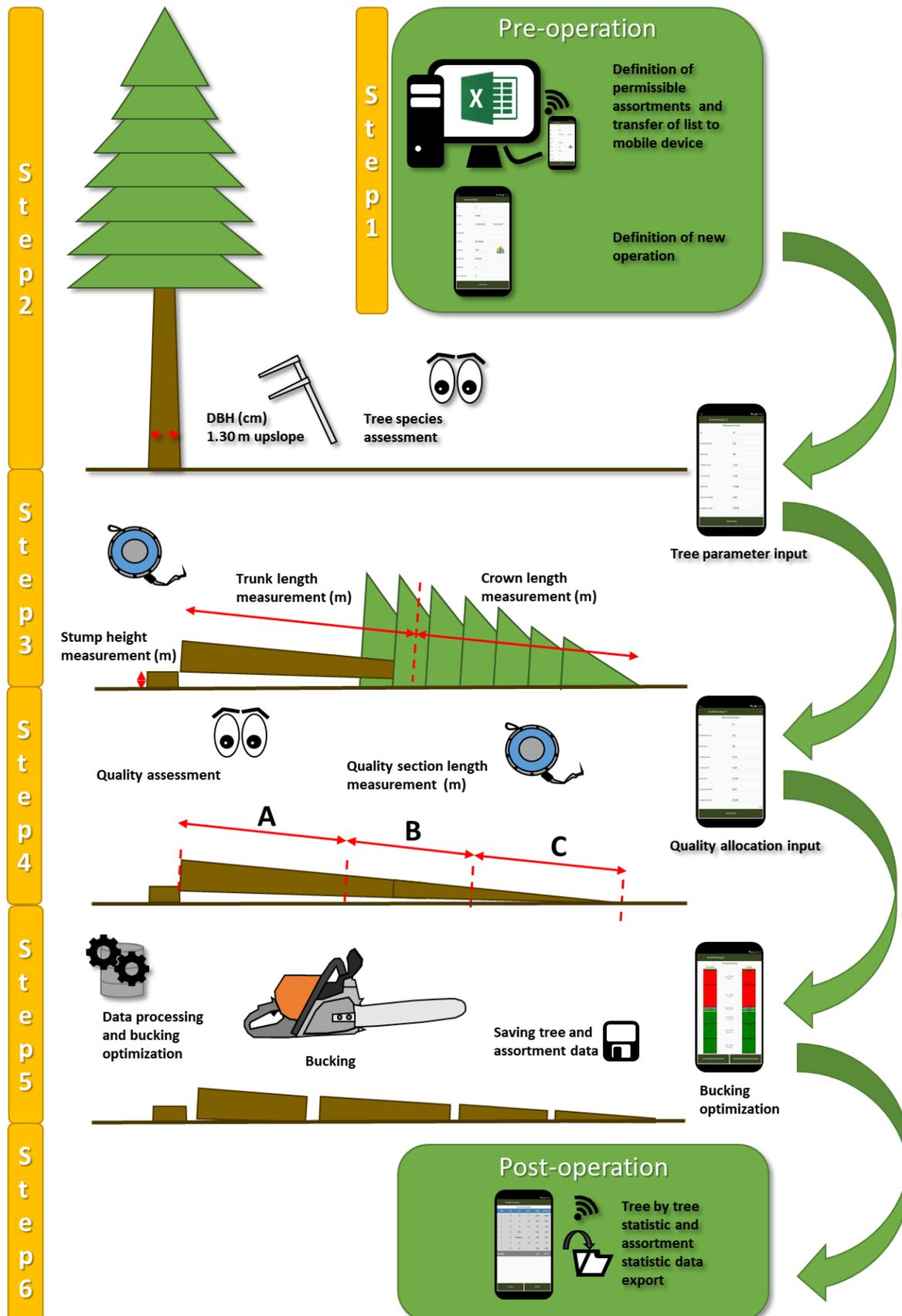


Fig 1: Procedure of working with the BUCKING App.

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3 Manual (Version 1.0, June 2018)

3.1 Bucking App availability

The Bucking App is as yet exclusively available for Android OS mobile devices from the Google Play Store via this link: <https://play.google.com/store/apps/details?id=com.latschbacher.buckingapp>

3.2 General Settings

3.2.1 Language

The operating language can be switched between German and English via selecting "**Language**" from the top-left menu on the **Operation Screen** (Fig 2).

3.3 Definition of permissible assortments

Before operating the Bucking App, the user has to define the permissible (1) assortments and (2) their respective prices. This is realized via a Microsoft Excel spreadsheet. Based on the user's contract, any permissible combination of (1) **species**, (2) **nominal length**, (3) **diameter class**, (4) **quality** and (5) **respective price per m³ without bark** is entered line by line in the respective columns. E.g. a fully defined assortment could be Norway spruce of 4 m nominal length, a diameter class 3a, a quality of B (second highest) and a price of 90 € m⁻³. This data is exported from the spreadsheet via a macro, which compiles an **exportable format file** readable to the Bucking App. The user has to name the file by which he can recognize it later. Multiple files containing permissible assortments and prices can be created. The compiled file can be **transferred to the mobile device** via any available means (cable, e-mail, Bluetooth etc.) and must be stored in the price list background folder via the devices file manager. Multiple assortment definitions can be created and stored.

3.4 Operation definition

After opening the Bucking App on the mobile device, the user views the **Operation Screen** (Fig 2) of the Bucking App. Via the Button "**New operation**" the user can create a new operation. At least one operation is required to start the bucking scheme optimization. When creating a new operation via the "**New operation**" button on the bottom-left of the screen or accessing an already created operation via "**Operation details**" from the top-right menu, the **Operation details Screen** (Fig 2) opens. Users can create multiple operations and switch between operations. Operations can be deleted via "**Delete**" from the top-right menu.

3.4.1 Meta-Data

On the **Operation details Screen** (Fig 2) operations are numbered subsequently (**No.**) and **operation start** (first tree bucked) and **end dates** (last tree bucked so far) are recorded and updated. Further, **geographical location** and **height above sea level** (mandatory) are either entered manually or can be retrieved from the mobile devices GPS-unit on-site. Further, additional information can be added (**operation name, user-specific information, stand designation, bucker's name**). Finally, the desired **assortment definition** intended to use for this operation has to be selected from the dropdown menu. All input is saved via the "**Save**" button at the bottom.

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3.4.2 Topping diameter and customized excess length

The user can configure the **topping diameter**, which is otherwise set to a default of 7 cm. The excess length is defined according to the Austrian timber trade guidelines. These define the excess length as 1.0 % (coniferous species) and 1.5 % (broadleaf species) of the nominal length with a minimum of 6 cm, regardless of nominal length and species. In order to resemble reality more closely, a user specific, additional excess length, which is added to the excess length required by the Austrian timber trade guidelines, can be defined. This **user specific excess length** can be configured individually per operation. Further, 1 cm is added to each assortment for the cutting slit.



Fig 2: Functionality of Operation and Operation details Screen.

3.5 Bucking

3.5.1 Required equipment

Apart from a mobile device for operating the Bucking App, having the Bucking App installed and completed the steps described in 3.1 to 3.4, the user needs to be equipped with **means for measuring diameters and lengths**. For the first task, either a calliper, a girth measurement tape or, with some limitations, a measuring tape can be used. For length measurement a measuring or logger's measuring tape is required.

3.5.2 Measurements and data input before felling

By selecting an operation and pressing "**Start bucking**" on the bottom-left of the **Operation Screen** (Fig 2), the **Tree Parameter Screen** (Fig 3) opens and data for the first tree can be entered. Data input starts with selecting the **Tree Species** (SP) from the dropdown menu. German language abbreviations are used for the species and correspond to English language species names as displayed in Tab 1. The next input parameter is the **diameter at breast height** (DBH, cm rounded down to the next integer) which is measured on the standing tree at 1.30 m on the upslope side of the tree.

Tab 1: English language equivalents to German language species abbreviations.

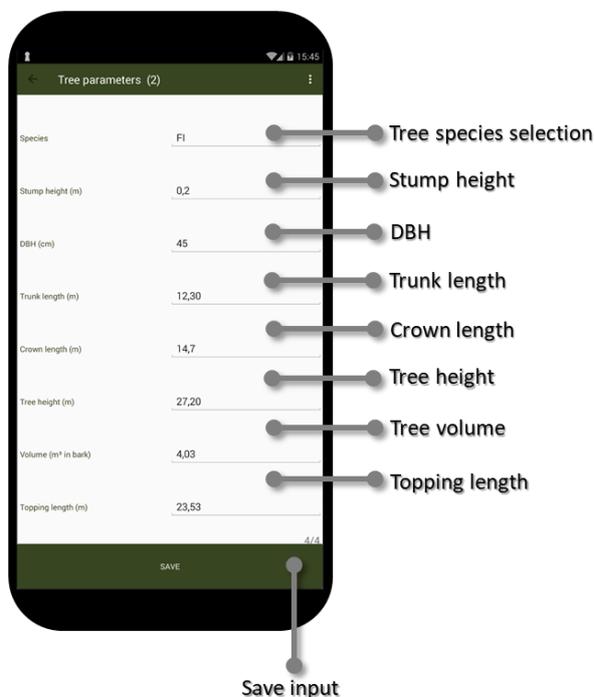
Species abbreviation	FI	TA	LA	WKI	BU
German language species name	Fichte	Tanne	Lärche	Kiefer	Buche
English language species name	Spruce	Fir	Larch	Pine	Beech

3.5.3 Measurements, assessment and data input after felling

After felling the tree, **stump height** (m) is measured on the upslope side of the tree. Then the **trunk length** (m) is measured from the felling cut to the crown base. The crown base is defined as the first branch whorl with at least one alive knot that is not followed by any branch whorl without at least one alive knot. Subsequently, the **crown length** (L, m) from the crown base to the crown tip is measured. Stump height, trunk and crown length measurements are put in the respective form fields on the **Tree Parameters Screen** (Fig 3). From these parameters, the **tree height** (m), the felled **tree's volume** in bark (m³) and **topping length** (m from felling cut) are calculated and displayed. Then the user proceeds to the **Quality Allocation Screen** (Fig 3) via the "Save" button.

Further, the user has to determine the **quality allocation** along the length of the tree and assign a start and end point for each quality. For the first quality section, starting from the felling cut, an end point is put in in the **End column** and a quality is selected from the **Quality column**. From the last **End column** value, the next **Start column** value is generated. To add further lines, "New line" is chosen from the top-right menu. This step is repeated till the tree length is reached. If the user encounters a section with a defect that shall not be included in the optimization, the quality "Defect" has to be selected and the respective start and end point has to be entered. To correct a line, "Delete last line" can be selected from the same menu. To proceed to the bucking optimization, the button "Optimize scheme" at the bottom has to be pressed.

Tree Parameters Screen



Quality Allocation Screen



Fig 3: Functionality of Tree Parameter and Quality Allocation Screen.

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3.5.4 Optimized bucking scheme

After pressing the **"Optimize scheme"** button, the **Optimized Bucking Scheme Screen** (Fig 4) opens and the value-optimized bucking scheme solution is presented. The table includes the columns **"Length"** (L, nominal length of the assortment in m), **"Start-End"** (S-E, start and end point of the assortment including standard excess length, user specific excess length and cutting slit in m from felling cut), **"Quality"** (Q, quality of the assortment), **"Diameter Class"** (DC, diameter class according to the middle diameter of the assortment according to Austrian Timber Trade Guidelines, middle diameter is determined from at half the nominal length from the top end of the assortment), **"Volume"** (V, m³ without bark) and **"Revenue"** (R, in € per assortment). Each line represents an assortment. The last line contains the part that is not utilized (Quality "Rest"), for which no diameter class, volume or revenue are displayed. Contrary, these parameters are displayed for defect sections. At the bottom, the sum of volume and revenue is displayed. If the user is satisfied with the suggested scheme, he can proceed to bucking via the **"Proceed"** button at the bottom left. If he wants to enter a customized bucking scheme, the **Customized Bucking Scheme Screen** (Fig 4) is opened by the **"Customize scheme"** Button.

3.5.5 Customized bucking scheme

The appearance of the customized bucking table is similar to the table in the **Optimized Bucking Scheme Screen** (Fig 4) however, here the user can alter nominal length and quality by choosing a different nominal length. Before specified defect sections cannot be removed during customized bucking. Schemes can repeatedly be altered and the results can be viewed via the **"Update"** button on the bottom right. If the user is satisfied with his choice, the **"Save"** button at the bottom left has to be selected to proceed to the **Comparison Screen** (Fig 5). On the **Comparison Screen** (Fig 5) the **Suggested Scheme** and the **Customized Scheme** are compared in terms of revenue, volume and utilized length and the difference is shown in the column **"Difference"**. By selecting the desired scheme and pressing the **"Buck"** button, the user proceeds to the visualization (**Bucking Screen**) (Fig 5).

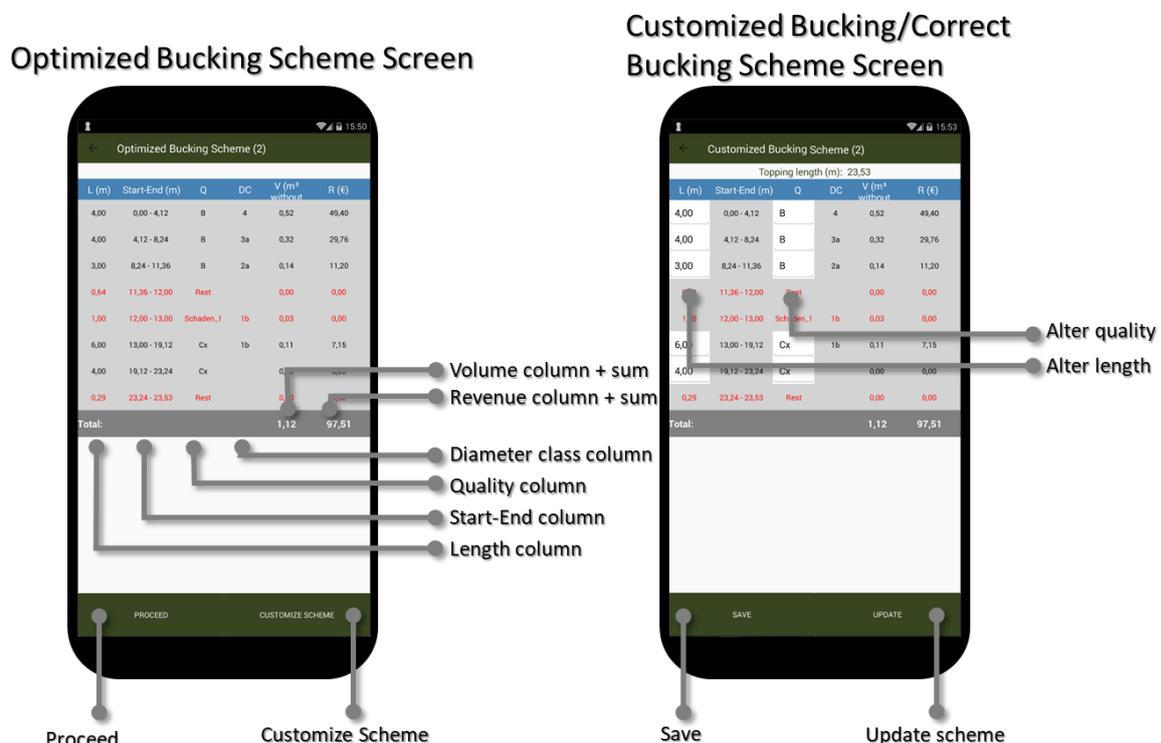


Fig 4: Functionality of the Optimized Bucking Screen, Customized Bucking Screen and Correct Bucking Scheme Screen

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3.5.6 Bucking

The **Bucking Screen** (Fig 5) shows two different visualisations of the tree, where the felling cut is located at the bottom of the screen and the tree top on the top of the screen. On the left hand side, the **Quality visualisation** displays the succession of assortment qualities, where assortments of the same quality are coloured alike. On the right hand side, the **Length visualisation** displays the assortments and the cutting points in meters from the felling cut. In the middle, assortment **Volume and Revenue** are displayed. If the user has finished bucking the tree according to the selected scheme, he can finalize bucking by pressing the **"Finish bucking"** button at the bottom left. Then data for the tree is saved to the statistics of the operation. If the user wishes to alter the bucking scheme during bucking, he has to proceed via the **"Correct scheme"** button at the bottom right. After pressing the **"Finish bucking"** button, the user is asked if he wants to proceed with the next tree or if he wishes to end bucking and return to the **Operation Screen** (Fig 2).

3.5.7 Alteration of bucking scheme during bucking

The **Correct Bucking Scheme Screen** (Fig 4) works similar to the **Customized Bucking Scheme Screen** (Fig 4) and as described in 3.5.5. Already cut assortments must not be altered. Differently to the customized bucking, no **Comparison Screen** (Fig 5) is shown after returning to bucking via the **"Save"** button.

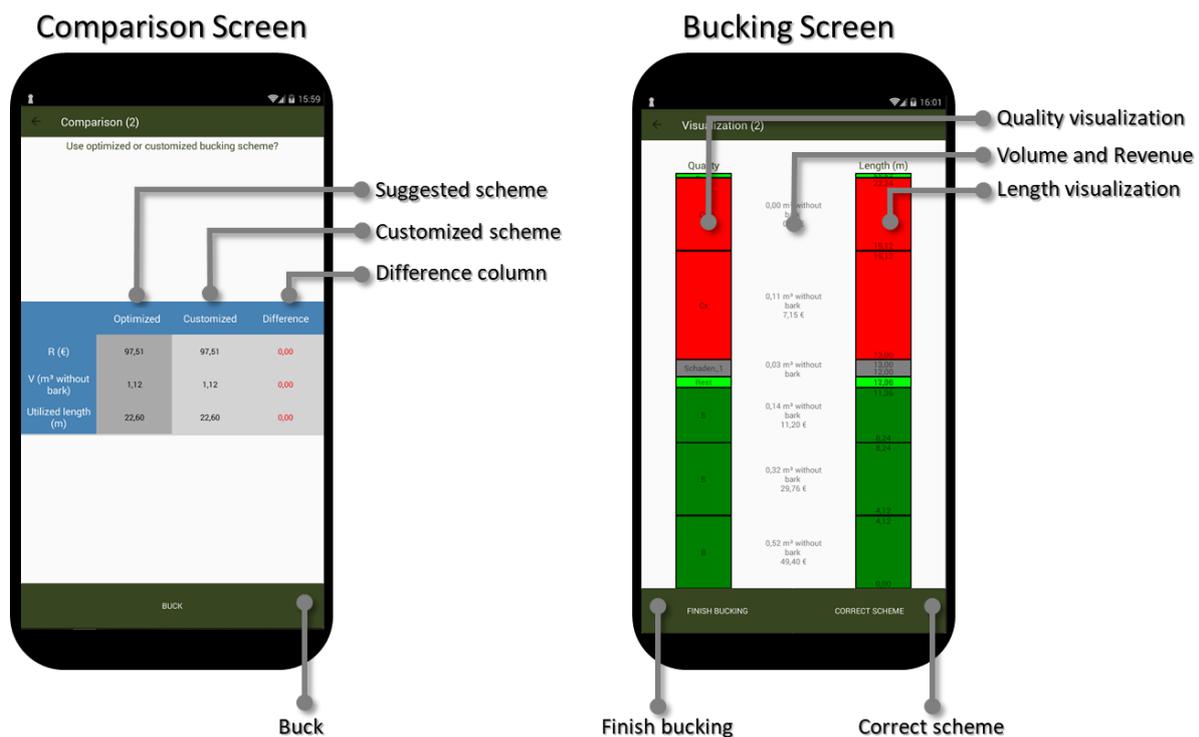


Fig 5: Functionality of the Comparison Screen and the Bucking Screen.

3.6 Statistics export

3.6.1 Tree by tree statistic

From the **Operation Screen** (Fig 2), the **Tree By Tree Statistic Screen** (Fig 6) can be accessed for the selected operation via the “**Tree by tree statistic**” button in the top right menu. The top table (**Tree Details**) line by line contains all trees saved to the operation, successively numbered. The columns include **Species (SP)**, **DBH**, **Tree height** (in m), **Volume without bark (V, in m³ per tree)** and **Revenue (R, in € per tree)**. By selecting a tree, the respective assortments from this tree are displayed at the bottom in a similar format as for the **Optimized Bucking Scheme Screen** described in 3.5.4 or the **Customized Bucking Scheme Screen** described in 3.5.5. Individual trees can be selected and deleted via the “Delete tree” button in the top right menu. This data can be exported via the “Export” button at the bottom right by any available means (cable, e-mail, Bluetooth etc.) as .pdf or .csv-file for external use. To return to the **Operation Screen**, the “Return” button at the bottom left is used.

3.6.2 Assortment statistic

From the **Operation Screen** (Fig 2), the **Assortment statistic Screen** (Fig 6) can be accessed for the selected operation via the “**Assortment statistic**” button in the top right menu. The table line by line summarizes all similar assortments defined by **Species (SP)**, **Nominal length (L)**, **Quality (Q)** and **Diameter class (DC)**. For each assortment, the **Cumulated numbers, Volumes and Revenues** are presented. This data can be exported via the “Export” button at the bottom right by any available means (cable, e-mail, Bluetooth etc.) as .pdf or .csv-file for external use. To return to the **Operation Screen** (Fig 2), the “Return” button at the bottom left is used.

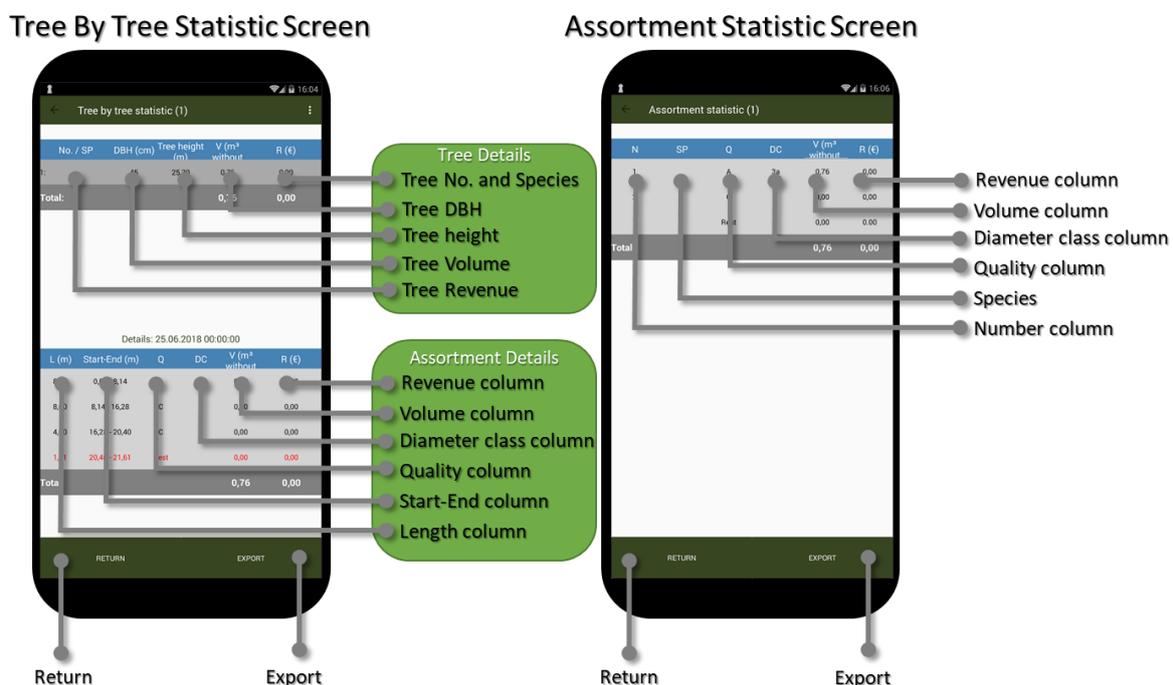


Fig 6: Functionality of the Tree By Tree Statistic Screen and the Assortment Statistic Screen.

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