Playing with Real-life numbers in Farming Simulator

Version 1.2.3.6 (adapted to Seasons)

By

ArmChairFarming

Preface

The most significant new feature in Farming Simulator 19 is the ability to design and build your own farmyard. A feature that more than any will facilitate and encourage individualization of the game, allowing players to build their farm either from pure fantasy or based on a real-life farm in their own neighborhood.

The present mod, **RealLifeNumbers by ArmChairFarming**, aims to allow further individualization of the game by providing easy access to key game parameters. The first objective of the model is to use real-life parameter values for various aspects of the game, including both arable farming and husbandry. Such real-life parameters are taken from official statistical services in the European Union (EU) and the United States Department of Agriculture (USDA). Over time, different versions will be published covering different member-countries in the EU and different USDA regions in the US.

This note aims to provide some background information on the series of scripts included in the mod, what parameters they alter, and what approach lies behind their new definition.

The mod differs from other mods in that the user must edit the mod to fit the mod to the game style and farm plan the user attempts to implement. This editing is done in between game play, and, particularly during the initial phase of a new game, when the farm is being designed and necessary plans need to be made to create a harmonious balance between the size of the husbandry and the size of the farmland.

The mod consists of a series of scripts each covering different areas. The mod offers very little visual interaction with the player. The mod scripts redefine Game parameters during game start up, and a very large number of defined and derived values are printed to the log file.

Finally, a brief note on the author of the mod. My name is Kaj-Åge "Ki" Henneberg. I'm a professor of engineering and teach mathematical modeling to engineering students. My only real-life experience with farming is my childhood life on my parent's small farm in the western part of Denmark in the 1960-1970. We had lots of pigs, barley and potato, a David Brown 880, a Farmall D-320, and about 50 acres of very sandy fields. My brother and I had our daily chores, mugging out the pigs was one of them, ploughing and cultivating were some in the fun end of the scale.

This is the first ever mod made by this author. The features as well as the programming style certainly reflect this very clearly. Starting with no knowledge of the data structure of Farming Simulator and no knowledge about Lua programming, the progress was very slow in the beginning. The mod uses scripts and will therefore not work on consoles. The mod is not written for multiplayer mode but reports from multiplayer users indicate that locally hosted multiplayer mode is possible to some degree. Multiplayer games on dedicated servers most likely will not work at all.

Who is **ArmChairFarming**? Just me. The expression "Armchair farming" was to my knowledge first used by George Saunders, a real-life British farmer and YouTube author, while comparing driving his much loved JCB 4220 in real-life and in FS17. Thank you, George, for letting me use it.

While enjoying immensely playing Farming Simulator, we all need external inspiration once in a while. This I get by watching YouTube videos from real-life farmers (George Saunders, MN Millenial Farmer, How Farms Work) as well as from game players and mod reviewers (Daggerwin, MrSealyP, Nick The Hick). Thank you all for teaching and inspiring me.

My final thank-you goes to all the hard core modders and mappers, who's complex codes make me feel like a newborn baby.

The redefined sell prices will only have their correct values when the economic difficulty level is set to HARD. Changing the economic difficulty level to Normal will scale the sell prices upward by a factor 1.8 and the Easy level will scale by a factor 3.

A second factor that can cause crop sell prices to deviate from the levels preset by the mod is if the map designer has implemented price-scaling at the sell points on the map. Some map designers do this systematically. To investigate if this is the case, you will need to unzip the map and inspect the xml files of each sell point in the placeables folder. Look out for the **pricescale** parameter. If different from one, the sell point is scaling the sell price. The same situation applies to user placeable sell points. It is a quickly mastered process of unzipping, editing and rezipping such maps and mods. I use the freeware program 7-ZIP to unzip and rezip files. Just remember, that the rezipped file should have the extension "zip", NOT "7z". I use the freeware editor Notepad++ to edit files. I recommend you do not edit mods while they are inside the FS19 mod folder. For this purpose, I have a series of folders: mods-unused, mods-edited, mods-conflicts, and so on.

A third factor to consider is the highly overexaggerated price variation built into FS19, causing price differences between sell points on the order of 100%. The mod attempts to reduce this variation, but it is hard to tell if the attempt has any effect.

Yours truly,

Kaj-Åge Henneberg
Mar. 20, 2019
Last updated: April 26th, 2020
Farum, Denmark

Figure 1. What lies ahead?

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1 Introduction

The mod **RealLifeNumbers** redefines the numerical values of a range of game parameters toward real-life values within a well-defined geographical region, either a country in the European Union (EU) or an agricultural region in the US as defined by the United States Department of Agriculture (USDA).

1.1 Objectives of the mod

The mod has three main objectives:

1. To define a game environment mimicking real-life farming in a well-defined area.
2. To enable players to individualize the game using a simple editor.
3. To provide a game planning tool for the player.

Ad 1) As time goes, maps will be available presenting farming in many different countries and within very different climatic environments. Farming thus is very different in different areas of the world, different crops are grown, different harvest yields are seen, and prices on crop, farm supplies, animals, milk, wool, farmland, etc. vary significantly. The first version (v. 1.0.0.1) of this mod contained real-life numbers for Germany, as I was playing on the maps Felsbrunn by Giants and Oberlausitz by RitchiF. Now there are flavors of the mod with data for the UK and US. All flavors are multifruit-ready.

Ad 2) There is only one right way of playing Farming Simulator: Your way. Whether you play the career game, building up a farm from scratch while fighting economic hardship with a 2-furrow plough or play a real-life simulation game, there is a need to tweak the game toward your personal playing style. While the mod aims to setup a real-life framework, it can easily be made to meet other personal game styles.

Ad 3) If your preferred style of playing is to do real-life simulation of farming in a specific geographical region, you need not only to redefine game parameters, you need also to do a pre-game setup, where you establish a good model of the farm you want to simulate. It is a real scoop for this game style, that FS19 now allows you to build your own farmyard. But many questions arise: How much land do I own? How many animals can I have if I have this much land? Can I afford buying more land or should I rent? What crop and how many hectares are needed to feed the animals? How many bales do I need of straw and grass? Do I have surplus crop for selling? What crop gives the highest income per hectare in my area? How much seed is needed? Should I lease rather than buy equipment? How much milk, wool, egg, manure and slurry do my animals produce? How much nutrient is in my organic fertilizer? How fast will my animal stock reproduce? What if I just want to rear fattening pigs? RealLifeNumbers provides the numbers and means you need to answer all these questions and more.

Seasons: The mod has some overlap with the Seasons mod by Realimus Modding. Consequently version 1.1.4.0 does not run with Seasons activated. All versions of RealLifeNumbers with a version number higher than 1.1.4.0 will strive to be compatible with Seasons. Version 1.2.0.0 will be the first Seasons compatible version of RealLifeNumbers. Version 1.2.0.0 is a reduced version of RealLifeNumbers, where animal care features have been removed in favor of the much stronger model introduced in Seasons. In version 1.2.2.0 a new predictive model has been introduced providing useful information for planning and building your farm.

1.2 Who is this mod for?

A real-life simulation game is entirely different from a career game in how you measure success and how you judge the means to reach your objective. In a career game, the framework is a predefined set of conditions and the way you act to resolve all the different challenges are also governed by a set of implicit rules. In a real-life simulation game, the initial setup phase is a design phase, where you in a very direct way establish the farming environment, you want to create. Only when this is accomplished does the game begin. In the setup phase, you will need to add money to your bank account repeatedly using a money cheat mod to buy/rent fields, level grounds, build your farm, and acquire starting animals and equipment as well as feed and farm supplies. This is an established farm, not a new farm, so there is already plenty of slurry in the pit and bales in the hayloft.

Some will say that this style of play is too easy. But planning a farm requires lot of knowledge and information about farming. RealLifeNumbers will make it easier by providing lots of needed information. Still, if you don't like to use a money cheat mod, you can make use of loans and make use of the mod features to lease land and equipment instead of buying.

Do not activate this mod, if you are in the middle of a career achievement game. The mod will change many economic parameters, and the economic achievements in your career game will take a different direction than what you started out with. If you want to use the mod, do it in a game, where your previous economic achievements are considered of minor relevance.

Deinstalling the mod will not bring back the original game parameter values. To obtain the original game parameter values you will need to reinstall the map. This can be done without interfering with your save game.

I strongly recommend that users of the mod make a back-up copy of the save game folder for the map they want to play before activating this mod.

1.3 The components of the original mod (version 1.0.0.1)

RealLifeNumbers has a modular structure in the sense that several separate scripts are called in the order defined in modDESC.xml. The following scripts are activated by default:

- `RealNumbersInitialization.lua`
- `RealNumbersCropYield.lua`
- `RealNumbersGreenCropYield.lua`
- `RealNumbersSpraying.lua`
- `RealNumbersSeedUsage.lua`
- `RealNumbersCropPrices.lua`
- `RealNumbersCommodityPrices.lua`
- `RealNumbersLeasing.lua`
- `RealNumbersAnimalProducts.lua`
- `RealNumbersAnimalCare.lua`
- `RealNumbersAnimalTradePrices.lua`
- `RealNumbersFieldInfo.lua`
- `RealNumbersContracts.lua`

The purpose of each script will be explained in the following sections.

1.4 The components of the previous mod (version 1.1.4.0)

This version has been updated to accommodate maps with an extended set of fruits (multifruit maps). This has required a complete redesign of how the mod reads game parameters. During the redesign of scripts, some scripts have been merged into one, and some features have been dropped in favor of new ones.

- `RealNumbersInitialization.lua`
- `RealNumbersCropYield.lua`
- `RealNumbersSpraying.lua`
- `RealNumbersCommodityPrices.lua`
- `RealNumbersLeasing.lua`
- `RealNumbersAnimalProducts.lua`
- `RealNumbersAnimalCare.lua`
- `RealNumbersAnimalTradePrices.lua`
- `RealNumbersFieldInfo.lua`
- `RealNumbersFarmland.lua`
- `RealNumbersContracts.lua`
- `RealNumbersVehicleMaintenance.lua`

The first script **RealNumbersInitialization** contains all the game parameters accessible for redefinition by the mod user. The original parameter values are obtained from statistical services and represent a specific country or agricultural region (US). The mod user is of course free to change the values as desired. In some cases, local values are unknown and representative values are taken from elsewhere, typically an average value in the European Union (EU) or from the US department of agriculture (USDA). In the script **RealNumbersInitialization**, parameters with geographical dependency have been marked “GEO” in the comment, followed by an indication of the country for which this value is valid. If an EU or US average is used, it will say “GEO EU” or “GEO US”. There are also parameters for which it is very difficult to get values. One such value is the price of seeds. Such parameters have been assigned a “reasonable” value and is marked “GEO COM”, as it is a value used commonly in all national versions of the mod.

RealNumbersCropYield has been completely rewritten and now combines the definition of crop yield with definition of seed usage and crop sell prices. The consequence is that the log report provides all this information sorted by crop types.

1.5 Version 1.2.0.0 (Seasons Ready)

The Seasons mod by Realimus Modelling offers a number of changes to the game that will create conflicts with version 1.1.4 of FS19_RealLifeNumbers. Two of the most significant changes are the models for growth of crops and the model for growth of animals. The growth pattern for crops is now influenced by the climate conditions. This means that the time for seeding and harvesting now are influenced by soil temperature and other climate factors. Therefore, version 1.2.0.0 of FS19_RealLifeNumbers will no longer make use of the time duration for crop growth phases. The mod parameter RN.growthDays.CROP is still present in the script, but not used.

With Seasons 2019, the animals follow a real-life growth curve, and feed intake and waste output will be a function of the current weight of the animal. This is a huge step forward in sophistication and the updated version of FS19_RealLifeNumbers will embrace this completely.

- `RealNumbersInitialization.lua`
- `RealNumbersCropYield.lua (lAlt-ry)`
- `RealNumbersSpraying.lua (lAlt-ru)`
- `RealNumbersCommodityPrices.lua`
- `RealNumbersLeasing.lua`
- `RealNumbersAnimalProducts.lua`
- `RealNumbersAnimalCareSeasons.lua`
- `RealNumbersFieldInfo.lua (lAlt-rf)`
- `RealNumbersFarmland.lua (lAlt-rt)`
- `RealNumbersContracts.lua (lAlt-rc)`

1.6 Recent additions, corrections and issues

Version 1.2.3.6

An intermediate release fixing a problem with cotton bales.

An economic prediction model has been added to help determine whether it is best to own equipment or to hire a contractor.

Version 1.2.3.5

This an intermediate release fixing a few issues.

Version 1.2.3.0

Version 1.1.0.0 of Seasons introduced snow contracts. This was an undefined contract type in RLN version 1.2.2.0 and could cause RLN to crash the game. Version 1.2.3.0 of RLN has added snow contracts and have also been modified to (hopefully) handle future undefined contract types more gracefully.

Version 1.2.2.0

The biggest update of this version is the reintroduction of a script for predicting feed amount, number of bales and field area to cover feed consumption of your animals. This feature was part of the mod before the appearance of Seasons 19 but had to be removed while making RealLifeNumbers compatible with Seasons 19. The script is described in a separate chapter.

Another change has to do with bale sizes. In version 1.2.1.0 bales sizes were readjusted to a predefined size. However, mod users have pointed out the importance of being able to work with a range of bale sizes in the same save game. The bale size is now calculated from the dimensions of the round bales and square bales. To change the volume of the default bales, you will need to change their size (diameter, width, length, height). Using the default sizes of bales, round bales are about 1500 L and square bales about 2600 L. Bales purchased in the store are 4000 L for both round and square bales. With this approach you can have small bales of 600 L, standard bales of 1500/2600 L, high density bales of 4000 L and Heston bales of 6000 L, all at the same time.

Some daily cost parameters have been adjusted. Vehicle Running Cost and Property Maintenance Cost are charged at the end of each game day. The mod now allows the user to adjust these costs by setting new mod parameter values. See more information in the section Commodity Prices.

Version 1.2.1.0

Random variation in crop yield has been cancelled in the default version. The reason for not including random yield in FS19_RealLifeNumbers is that the Seasons mod already creates a much more realistic yield variation due to weather conditions and crop rotation. It can easily be reactivated. In the script RealNumbersCropYield.lua set `randomness = 1` in line 132.

Following user requests, the approach to field renting has been redesigned. Using the seasonal calendar created by the Seasons mod, all field rent contracts are now terminated on the first day of mid-winter. It can be renewed, starting on following day. The termination day can be modified by the user. The rent price now automatically decreases based on how many game days are left until the rent termination day. Hence, if you only rent a field for half of the rent year, you will only pay half of the full year rent. On the rent termination day, the rent price is zero. You can rent fields on that day, but the contract is cancelled at no loss. If you rent a field in the first half of the rent year and later decide to cancel the rent contract, you will be reimbursed an amount corresponding to rent cost for the remainder of the rent-year. If you have seeded/planted winter crop on a rented field, you will not own the field on the rent termination day, however, you can renew the rent contract on the following day, and then carry on carrying for your crop.

Two types of issues have been reported on contracts/missions. The first is related to fertilizing contracts. Often it is impossible to complete a fertilizer contract, if the field has already been fertilized once. It is unclear what causes this issue. The same issue has been recognized by Realismus Modding, the author of the Seasons mod. To reduce the likelihood that FS19_RealLifeNumbers should be the cause of this issue, the script RealNumbersContracts.lua has been rewritten so that it no longer writes data to the mission parameter table but only reads values from this table. This has no consequence for how the mod user experience this script. Despite the changes, the issue remains.

Another issue with contracts relates to plow and cultivation missions. FS19_RealLifeNumbers normally writes the crop type associated with the field on which a contract is done. However, for plowing and cultivation contracts, the associated crop types are reset to undefined when the contract nears its completion, causing FS19_RealLifeNumbers to write error statements to the log file. This has been fixed simply by not writing a crop type to the log file for plow and cultivation contracts.

Version 1.2.0.0

Crop growth duration has been dropped.

Prediction of fertilizer amount has been adjusted to fit three fertilizing stages. Each application covers one third of the total needed application for the given fruit type.

Bales bought in the store are listed with their defined volume. For unknown reasons they spawn as 4000 L bales. This seems to have started with patch 1.4. An attempt has been made to correct this. The bales will not have the correct volume until the game is reloaded. This means that newly bought bales should be put in storage and not used until a later game play.

The whole script AnimalCare has been replaced by a new script AnimalCareSeasons. The new script allows the player to change parameters for feed intake and waste output, but not parameters for the growth model.

Seasons redefines the service interval for equipment. A similar script in FS19_RealLifeNumbers has therefore been removed. The user can change the service interval by changing that parameter in the Seasons mod.

This version of FS19_RealLifeNumbers does not offer information about how much feed and crop acreage is needed for a given herd. Such information should ideally be predicted from the Seasons models for animal growth and crop yield. There is currently no information available for modders to explain the model parameters, hence I believe a better approach is to develop a prediction model relying on statistical data from real life. I hope to be able to include this feature in a future version of the mod. (This information has been reintroduced in version 1.2.2.0).

Multiplayer mode

The mod was not initially intended for multiplayer mode because Giants does not make information available for making mods multiplayer ready. It turns out, that the mod is somewhat multiplayer capable, if a local host is used (not a dedicated server). To enhance the degree of multiplayer-readiness, a few modifications were tested in multiplayer mode using a host and client on the same local-area network. If a dedicated server is not used, a wide-area network should also work.

Certain game parameters can only be seen by the host. This applies in particular to the parameters worked on in the script **RealNumbersContracts**. Pressing lAlt-rc on the host will display both a general contracting pricelist but also itemized contracts for current contracting jobs. The host does not share this information with the clients; hence the itemized contracts are not printed out on client PCs. The client PC can still do the contract jobs and receive the correct reward, but an itemized contract is not printed.

1.7 How to use the mod

RealLifeNumbers does most of its job during game startup. User interaction with RealLifeNumbers is outside the game. If a mod user feels that the predefined numbers should be changed, this needs to be done using a simple editor. Notepad could be used, but Notepad++ is much better as it recognizes the lua syntax. To facilitate the recurrent interaction with the scripts, it is recommended to unzip a copy of the mod into a dedicated folder and keep this folder at all times. If a parameter value needs to be changed, open the specific script in Notepad++, make the change, save the script and make a new zip file with all the files in the folder. Then drag the new zip file to the folder with your mods and restart the game. This manual does not need to be inside the zip file when using the mod.

RealLifeNumbers prints all information to the log.txt file. The information is mixed with loading information from all other mods in the game. This seems a bit confusing, but as the user only needs this information occasionally, it is an easy one-time task to edit out irrelevant loading information using a text editor and thereby create a map specific report. For use in the game planning phase, this report can be printed out on paper or converted to a pdf file and displayed on a tablet conveniently located next to your game computer.

This simplistic style of user-mod interaction may seem too complicated or annoying to many players. If this is the case, I believe your game style will not benefit much from the mod and you will be better off not using the mod. Players who play the game as a real-life simulator are used to making records of harvest yields and other information in a small note book. Hopefully, this group of players will find the simplistic approach manageable.

It may be of some convenience to see the log file on the screen while playing the game. This can be done by editing `game.xml` located in the folder `Documents\My Games\FarmingSimulator2019`. In this file,

```
<development>
        <controls>false</controls>
</development>
```

should be changed to:

```
<development>
        <controls>true</controls>
 </development>
```

When starting the game, you may then press the key just below the Esc key on your keyboard. Whatever is written to the log file will also be copied to the screen, but unfortunately not in fixed-width font. By using the Page Up/Down keys, you can browse through the output from the mod to get a quick look at something without leaving the game. Pressing the button just below the Esc key two times more will make the text disappear from the screen and you can continue playing the game.

To ensure that the mod gives you the expected results, **you must play the game with Economic Difficulty set to HARD**. At normal economic level, prices will be scaled by 1.8, and at EASY, they will be scaled by 3. This scaling is done by FS19, not by this mod.

First time on a map? The mod reads files in the savegame folder. Hence for the mod to work as intended, you will need to save the game, exit, and then reenter the game the first time you play on a map.

1.8 Keyboard shortcuts

There are some keyboard shortcuts you will have to use to obtain some of the information produced by the mod. They are summarized in Table 1.

Table 1. Keyboard shortcuts.

lAlt-rh	:	This overview
lAlt-ra	:	Animal information
lAlt-rb	:	Bale information
lAlt-rc	:	Contract information
lAlt-rd	:	Game day information
lAlt-re	:	Economy information
lAlt-rf	:	Field information
lAlt-rt	:	Land information
lAlt-ru	:	Fertilize information
lAlt-ry	:	Yield information
lAlt-rw	:	Environment information

1.9 What if I find a mistake?

It is very likely a user will disagree with one or more parameter values set by the mod. If the value in question is a factor 10 off from the value you think it should be, then it is likely, that I or the data source have made an error, and I would be glad to hear about it. If you disagree because you live in a part of the world with unusually high milk or oat yield, then simply refit the parameter values to match your situation. After all, individualization is one of the main aims of the mod.

In the derivation of game parameters, I have used a range of methods. Some take root in factual information published by universities or farming organizations and others are just rules of thumb found on the internet. In the latter case there might be better methods and I would like to hear about them.

1.10 Coexistence with other mods

A range of good mods change some of the same parameters as redefined in this mod, such as crop yield, seed usage and prices on crops and farm supply. If used simultaneously with RealLifeNumbers, conflicts will arise as to what value the parameters will end up having. Most other mods with this issue have entirely different objectives, hence it should be of no consequence to simply disable these mods when using RealLifeNumbers.

I use three mods, which supports RealLifeNumbers particularly well, **variableSprayUsage** by monteur1, **helperAdmin** by apuehri/LS-Modcompany and **VariableBaleCapacity** by sperrgebiet.

variableSprayUsage by **monteur1** adjusts the running output rate of spreaders and sprayers according to the current driving speed. This mechanism prevents over/under-application of spray material in areas of the field with varying driving speed, such as at headlands an on very hilly fields. The user can set the spray rate in Liters/hectare. It is easy to edit the mod and extend the range of possible settings, so the mod can be set to deliver the spray rates calculated by the script

RealNumbersSpraying. To assist this adjustment, **pressing left Alt-ru** will cause the script **RealNumbersSpraying** to print the pre-set spray rates in the log file (and on the screen if development is set to true in game.xml and the log file is made visible by pressing the key below the ESC key once).

helperAdmin allows you to adjust the price per hour paid to helpers. **Seasons** also sets this parameter. So, there is a big chance that these mods will conflict. To use real-life wages, values need to be edited in these mods.

VariableBaleCapacity by **sperrgebiet** allows you to calibrate balers to produce bales of different volumes. I use it to calibrate round-balers to 1500 Liters and square-balers to 2600 Liters. These numbers are not default numbers in the mod by sperrgebiet. You can either change the numbers inside the mod, or you can change the numbers in the XML file in the mod-settings folder. There is a version of this file for each save game. If this file exists, this value will be used, even if you have changed numbers inside the mod. I have changed the numbers both in the mod and in the XML file for each save game.

From version 1.2.2.0, the volume of both round and square bales bought in the store are equal to the default in-game value of 4000 Liters.

2 Parameter definition

To facilitate easier location of the model parameters, far the majority of parameters are defined in the script **RealNumbersInitialization**. The parameters defined here are then passed on to the following scripts for processing. You can change the value of existing parameters, but you should not change the name of the variable. If there is a comma separator or a brace "}" behind a number, it must not be removed. All parameters defined here are stored in a global table "RN". Elements in the global table then follow the naming convention RN.cropDensity, RN.soilType, RN.annualLoanInterest, and so on.

Table 2. Crop input parameters. Many more crop types are included.

```
RN.fruits.ASPARAGUS              = "ASPARAGUS";
RN.cropDensity.ASPARAGUS         = 0.325; -- kg/L
RN.cropYield.ASPARAGUS           = 54.37; -- GEO DE, 100 kg/ha
RN.yieldRange.ASPARAGUS          = 0.179; -- GEO DE
RN.seedDensity.ASPARAGUS         = 0.288; -- kg/L
RN.TSM.ASPARAGUS                 = 257;   -- 1000 seed
RN.plantsPerSqm.ASPARAGUS        = 40;    -- number of plants per sqm
RN.germination.ASPARAGUS         = 90;    -- Percentage of seeds that germinate
RN.seedUsagePerSqm.ASPARAGUS     = 0;     -- kg/sqm,
RN.seedPricePer100kg.ASPARAGUS   = 46.00;      -- GEO COM price / 100 kg
RN.cropPricePer100kg.ASPARAGUS   = 419.50;     -- GEO DE price / 100 kg
RN.seederCalibration.ASPARAGUS   = 1.000;      -- If seeder calibration is wanted.
RN.Nitrogen.ASPARAGUS            = 100;  -- kg/ha Nitrogen  (N) fertilizer per year
RN.Phosphate.ASPARAGUS           = 11 ;  -- kg/ha Phosphate (P) fertilizer per year
RN.Potassium.ASPARAGUS           = 70;   -- kg/ha Potassium (K) fertilizer per year
RN.cropProtectionCost.ASPARAGUS= 245;
RN.growthDays.ASPARAGUS          = 60;

RN.fruits.BARLEY                 = "BARLEY";
RN.cropDensity.BARLEY            = 0.618; -- kg/L
RN.cropYield.BARLEY              = 64.94; -- GEO DE, 100 kg/ha
RN.yieldRange.BARLEY            = 0.237; -- GEO DE,
RN.seedDensity.BARLEY            = 0.618; -- kg/L
RN.TSM.BARLEY                    = 40;   -- 1000 seed mass
RN.plantsPerSqm.BARLEY           = 360;  -- number of plants per sqm
RN.germination.BARLEY            = 90;   -- Percentage of seeds that germinate
RN.seedUsagePerSqm.BARLEY        = 0;    -- kg/sqm,
RN.seedPricePer100kg.BARLEY      = 37.00;-- GEO DE, price / 100 kg
RN.cropPricePer100kg.BARLEY      = 15.50;-- GEO DE, price / 100 kg
RN.seederCalibration.BARLEY      = 1.000;-- If seeder calibration is wanted.
RN.Nitrogen.BARLEY               = 140;  -- kg/ha Nitrogen  (N) fertilizer per year
RN.Phosphate.BARLEY              = 25 ;  -- kg/ha Phosphate (P) fertilizer per year
RN.Potassium.BARLEY              = 40;   -- kg/ha Potassium (K) fertilizer per year
RN.cropProtectionCost.BARLEY     = 70;   --
RN.growthDays.BARLEY             = 110;
```

We all make mistakes. It is therefore strongly advised that you keep backups of RealNumbersInitialization.lua. To remember the original value, I often copy/paste the original number into the comment field (a comment starts with "- -") before overwriting it with a new value.

The standard fruits: Barley, canola, cotton, drygrass, grass, maize, oat, oilseed radish, poplar, potato, soybean, sugar beet, sugarcane, sunflower, weed, wheat.

The extra fruits: Alfalfa, asparagus, beans, black beans, cabbage, carrot, clover, coffee, cranberry, dry lucerne, hemp, hops, incarase grass, lettuce, lucerne, millet, mustard, onion, peanut, peas, poppy, red cabbage, rice, rye, sorghum, spelt, sudan grass, tobacco, triticale, white cabbage.

The mod reads all fruit types included in a given map. If the same fruit type is also defined in RealLifeNumbers, then parameters from RealLifeNumbers are used. Otherwise map data is used. For a map with fewer fruits, the unused fruits will be ignored. For a map with more fruits, map data will be used for the fruits missing in my mod. Map data for fruits may not be real-life data, hence a much higher yield or sell price could possibly be observed for those extra fruits, which have not been defined in my mod. An example of fruit definitions is listed in Table 2.

While the RN.growthDays parameter has been kept for reference, it is not used. Seasons now determines the number of days between seeding and harvesting.

A new parameter **cropProtectionCost** has been added. It contains an estimate of the total expense for chemicals (herbicides, fungicides, pesticides) applied to the crop. Its application is only to make a **Cost of Production** calculation for each crop.

3 Crop yield

The script **RealNumbersCropYield** sets the bulk material density and harvest yield of the crops. For crop producing straw, the windrow yield is also set. A short excerpt is shown in Table 3. The log file contains parameter values for all crops on the map.

Values for bulk crop density vary depending on the crop variety and moisture content. In this mod, values have been obtained from the agricultural service of the province of Alberta, Canada as well as from numerous documents posted on the internet.

Values for crop yield depends very much on climate, geographical location and intensity of field preparation and fertilization. For maps within EU, crop yield values have been obtained from the statistical service of the European Union (EUROSTAT). In EU, annual yields are averaged from 2009 to 2018. Similar data is available from the USDA for the 12 agricultural regions in the US. As time allows, mod versions will be released with data from other EU countries and from different agricultural regions in the US.

Figure 2. Harvesting. What yield to expect?

The information about crops can be used to select between crops and to determine how many hectares are needed, if you need a known amount of feed or number of bales. The price information allows the user to compare income per hectare for different fruits, a much more valuable information than the crop yield if you plan to sell your harvest.

Table 3. Example of calculated grain crop output data printed to the log. New parameters are in bold.

BARLEY massPerLiter	=	0.6180	kg/L
Yield randomness scaling	=	1.0000	
BARLEY base yield	=	0.4833	L/sqm
BARLEY base yield	=	4833	L/Ha
BARLEY no-plough loss	=	725	L/Ha
BARLEY no-weeding loss	=	967	L/Ha
BARLEY liming gain	=	725	L/Ha
BARLEY 1x fertilizing gain	=	805	L/Ha
BARLEY max yield	=	9667	L/Ha
BARLEY windrowLiterPerHa	=	34925	L/Ha
BARLEY round bales Per Ha	=	23.4395	Bales/Ha
BARLEY square bales Per Ha	=	13.4845	Bales/Ha
BARLEY seed Mass Per Liter	=	0.6180	kg/L
BARLEY seed Mass Per Ha	=	93.3333	kg/Ha
BARLEY seed Volume Per Ha	=	151.0248	L/Ha
BARLEY seed Cost Per Liter	=	0.2966	€/L
BARLEY seed Cost Per Ha	=	44.8000	€/Ha
BARLEY NPK Cost Per Ha	**=**	**185.3500**	**€/Ha**
BARLEY Crop protection CostPerHa	**=**	**70.0000**	**€/Ha**
BARLEY Supply costs Per Ha	**=**	**300.1500**	**€/Ha**
BARLEY price Per 1000 Liter	**=**	**95**	**€/1000 L**
BARLEY Gross income per ha - no loss	**=**	**920**	**€/Ha**
BARLEY Net income per ha - no loss	**=**	**620**	**€/Ha**
BARLEY Straw-bale income per ha	**=**	**580**	**€/Ha**

Table 4. Example of calculated vegetable crop output data printed to the log. New parameters are in bold.

CARROT			
CARROT massPerLiter	=	0.6410	kg/L
Yield randomness scaling	=	1.0000	
CARROT base yield	=	3.7711	L/sqm
CARROT base yield	=	37711	L/Ha
CARROT no-plough loss	=	5657	L/Ha
CARROT no-weeding loss	=	7542	L/Ha
CARROT liming gain	=	5657	L/Ha
CARROT 1x fertilizing gain	=	6285	L/Ha
CARROT max yield	=	75423	L/Ha
CARROT seed Mass Per Liter	=	0.4000	kg/L
CARROT seed Mass Per Ha	=	2.7625	kg/Ha
CARROT seed Volume Per Ha	=	6.9063	L/Ha
CARROT seed Cost Per Liter	=	49.2000	€/L
CARROT seed Cost Per Ha	=	339.7875	€/Ha
CARROT NPK Cost Per Ha	**=**	**425.1500**	**€/Ha**
CARROT Crop protection CostPerHa	**=**	**230.0000**	**€/Ha**
CARROT Supply costs Per Ha	**=**	**994.9375**	**€/Ha**
CARROT price Per 1000 Liter	**=**	**155**	**€/1000 L**
CARROT Gross income per ha - no loss	**=**	**11700**	**€/Ha**
CARROT Net income per ha - no loss	**=**	**10705**	**€/Ha**

Crop yield varies from year to year. For some crops it varies more than for others (Table 5). Standard deviation is a statistical measure of how much a set of numbers deviates from their mean value. If the frequency of outcomes in a random process is bell-shaped it is called a normal distribution. About 96 percent of all outcomes with a normal distribution lies within +/-2 standard deviations. It has not been investigated whether variations in crop yield have a normal distribution. Nevertheless, this measure is used here to create reasonable variation in crop yield. The right most column in Table 5 shows the assumed maximum variation divided by the mean, hence presenting yield variation as a fraction of the mean yield. Root crops vary less than 10%, grain crops about 20%, and oilseeds, canola, sunflower and soybean between 36 and 42% in the EU.

Table 5. Mean and variations in crop yield. Germany, 2009 – 2018.

Crop	Mean yield (100 kg/ha)	Variation/mean 2 std/mean
Wheat	75.81	0.198
Barley	64.94	0.237
Oat	46.00	0.254
Maize	96.25	0.213
Potatoes	430.7	0.090
Sugarbeet	729.2	0.071
Oilseeds	36.54	0.363
Canola/rape	36.16	0.383
Sunflower	20.56	0.460
Soybeans	29.23	0.416

FS19_RealLifeNumbers has a feature for adding randomness to the crop yield. However, this approach is purely a matter of random scaling with no bearing on weather conditions, crop rotation and other real-life factors which influence yield. The **Seasons** mod adds crop yield variation based on weather conditions and crop rotation; hence I see no real use for that feature in FS19_RealLifeNumbers. If a user wants additional variation the feature can be turned on by setting the variable `randomness = 1`.

Seasons: Some limited testing shows no sign that the Seasons mod overrides the yield parameters defined by RealLifeNumbers. My tests show yield variations within +/- 20% confirming that the Seasons mod influences crop yield in a satisfactory manner.

The windrow yield by weight is defined as 80% of the grain yield by weight. The windrow yield by volume is calculated using the mass density of a straw bale here set to 0.13 kg/L ($8\,\frac{\text{lb}}{\text{ft}^3}$). A windrow loss of 5% is incorporated. These scaling parameters are set so that the straw bale yield is around 27 round bales and 20 square bales per hectare.

The growing days for crops, i.e. the number of days from seeding to harvest varies from one crop to another and from one geographical location to another. The USDA has published data on planting and harvest dates for a range of crops grown in the US. Figure 3 shows an example for spring barley. By counting the days between the middle seeding date and the middle harvest date, the number of growth days has been determined for a range of crops.

Seasons: Now Seasons controls the duration of the growth season. The growthdays parameter in RealLifeNumbers has no effect but has been kept for reference purpose.

For some crops, statistical information is missing at EUROSTAT/USDA for a given country or agricultural region. In such cases, either the EU average is used, or the US average is used. The most likely reason why such values are missing is that the crop is not grown in this part of the world. Although possible, mod users playing for realism should question the idea of growing cotton, coffee, sugarcane or tobacco in Northern Europe.

Barley, Spring: Usual Planting and Harvesting Dates, by State

State	1996 Harvested Acres (000)	Usual Planting Dates			Usual Harvesting Dates		
		Begin	Most Active	End	Begin	Most Active	End
AK	6.9	May 5	May 10 - May 25	Jun 5	Aug 20	Sep 1 - Sep 25	Oct 5
CA 1/	200	Feb 20	Mar 1 - May 1	May 15	Aug 15	Sep 1 - Sep 20	Oct 1
CO	92	Mar 15	Apr 5 - May 5	May 15	Jul 10	Jul 25 - Sep 5	Sep 20
ID	730	Mar 24	Apr 7 - May 5	May 26	Jul 28	Aug 11 - Sep 8	Sep 29
KS 2/		Mar 1	Mar 5 - Apr 1	May 1	Jun 10	Jun 25 - Jul 1	Jul 10
MI	25	Apr 15	Apr 25 - May 8	May 21	Jul 26	Aug 3 - Aug 19	Aug 31
MN	520	Apr 16	Apr 26 - May 27	Jun 5	Jul 26	Aug 8 - Sep 7	Sep 24
MT	1,200	Apr 7	Apr 21 - May 14	Jun 1	Aug 4	Aug 15 - Sep 6	Sep 28
NE	17	Mar 20	Mar 25 - Apr 10	Apr 18	Jul 18	Jul 20 - Jul 25	Jul 30
NV 1/	5	Apr 5	Apr 15 - May 15	May 20	Jul 20	Jul 25 - Aug 25	Sep 5
ND	2,600	Apr 21	May 2 - May 15	May 26	Jul 30	Aug 8 - Aug 23	Sep 6
OR	150	Sep 1	Mar 30 - May 15	May 15	Jul 5	Aug 5 - Aug 25	Sep 1
SD	145	Apr 6	Apr 17 - May 5	May 20	Jul 12	Jul 23 - Aug 8	Aug 20
UT	100	Mar 20	Apr 1 - Apr 20	May 10	Jul 15	Jul 25 - Aug 15	Sep 1
WA	440	Mar 1	Apr 1 - Apr 30	May 20	Jul 15	Aug 1 - Aug 30	Sep 15
WI	75	Apr 5	Apr 10 - May 10	May 15	Jul 15	Jul 25 - Aug 20	Sep 1
WY	120	Mar 15	Mar 28 - Apr 28	May 28	Jul 29	Aug 8 - Aug 31	Sep 21

Figure 3. US seed and harvest days for spring barley.[1]

A few new calculated values have been added in the crop output tables (shown in bold text in Table 3 and Table 4). They highlight supply cost for fertilizer and chemicals used for crop protection. The gross income from selling the harvested crop as well as the net income (gross income - supply cost) are shown. Net income is not profit. Net income must pay the variable and fixed costs of equipment. A new script predicting equipment economy is presented in a later chapter.

[1] https://swat.tamu.edu/media/90113/crops-typicalplanting-harvestingdates-by-states.pdf

Figure 4. Harvesting cabbage.

Figure 5. Harvesting carrots.

Vegetable crops tend to give yields comparable to root crops but have a higher sell price and a shorter growth season. Many vegetable crops can have two harvests per year, making vegetable crops very profitable compared to grain crops, even when real-life numbers are used.

There is no doubt, that playing with the mod FS19_RealLifeNumbers, the player is experiencing a much bleaker economy than in the standard game. However, using multifruit maps with plenty of vegetable fruits and renting fields and expensive harvesters instead of buying, can improve the economy.

In my perspective, leasing a harvester and putting a helper on it, is like hiring a contractor. Some players argue, leasing for a few days is unrealistic, and I agree. If a farmer leases a tractor, it would be for several years. On the other hand, when it comes to harvesters, there is no point in long term leasing, unless you roleplay as a contractor. Short term leasing of harvesters is quite legitimate if you perceive it as hiring a contractor for a few days to harvest your crop. At lot more is to be said in a later chapter on equipment economy

4 Grass, hay, and silage yield

In Farming Simulator, a round bale has a diameter of 1.3 m and a height of 1.12 m, giving it a volume of 1487 Liters. Square bales are 1.2 m x 0.9 m x 2.4 m giving it a volume of 2592 Liters. Regardless of the actual dimensions of the bales, Farming Simulator sets the standard bale volume at a very large 4000 L. Using the mod **VariableBaleCapacity** by sperrgebiet, I set the baler to produce round bales of 1500 L and square bales of 2600 L. This requires editing the possible bale volumes in the mod and the modsettings files using a text editor.

Table 6. Yield of grass per cut. Round bales = 1500 L, square bales = 2600 L.

```
GRASS massPerLiter                      =      0.3900  kg/L
Yield randomness scaling                =      1.0000
GRASS base yield                        =      2.7588  L/sqm
GRASS base yield                        =   27588      L/Ha
GRASS no-plough loss                    =    4138      L/Ha
GRASS no-weeding loss                   =    5518      L/Ha
GRASS liming gain                       =    4138      L/Ha
GRASS 1x fertilizing gain               =    4598      L/Ha
GRASS max yield                         =   55177      L/Ha
GRASS windrowLiterPerHa                 =   52418      L/Ha
GRASS round bales Per Ha                =     35.1799  Bales/Ha
GRASS square bales Per Ha               =     20.2386  Bales/Ha
GRASS seed Mass Per Liter               =      0.3100  kg/L
GRASS seed Mass Per Ha                  =      8.5556  kg/Ha
GRASS seed Volume Per Ha                =     27.5986  L/Ha
GRASS seed Cost Per Liter               =      2.2320 €/L
GRASS seed Cost Per Ha                  =     61.6000 €/Ha
GRASS NPK Cost Per Ha                   =    228.6100 €/Ha
GRASS Crop protection CostPerHa         =    154.0000 €/Ha
GRASS Product costs Per Ha              =    444.2100 €/Ha
GRASS price Per 1000 Liter              =      25     €/1000 L
GRASS Gross income per ha - no loss     =    1370     €/Ha
GRASS Net income per ha - no loss       =     926     €/Ha
```

The density of grass and silage bales is set to $0.39\frac{kg}{L}$ and that of hay bales to $0.18\frac{kg}{L}$. A 1500-liter round silage bale then weighs $585\ kg$ and a hay round bale $270\ kg$. Square bales weigh $1014\ kg$ and $468\ kg$.

The yield of grass, clover and alfalfa/Lucerne is calculated based on an assumed value of annual drymatter production per hectare.

Table 7. Growth parameters for grass, clover and alfalfa. (In RealNumbersInitialization).

```
RN.annualGrassCuttings               =   2;
RN.annualAlfalfaCuttings             =   3;

RN.growth.grassDryMatterMassPerHa    = 17000/RN.annualGrassCuttings;
RN.growth.alfalfaDryMatterMassPerHa  = 16000/RN.annualAlfalfaCuttings;
RN.growth.cloverDryMatterMassPerHa   = 15000/RN.annualGrassCuttings;
```

Alfalfa is usually cut more times per year than grass and clover. Here we assume that grass and clover is cut two times and alfalfa three times per year. The number 17000 is the annual amount of dry matter in kg/ha for grass, and similar for clover and alfalfa. To get the mass per hectare of dry mater per cutting, the annual amount is simply divided by the number of cuttings per year. If we divide this number by the dry matter fraction, we get the fresh matter mass per hectare per cutting. Here we need to distinguish between cutting for silage or for hay.

Table 8. Dry matter fraction in grass, silage and hay.

```
RN.growth.alfalfaDryMatterFraction          = 0.350;
RN.growth.cloverDryMatterFraction           = 0.375;
RN.growth.grassDryMatterFraction            = 0.395;

RN.growth.dryalfalfaDryMatterFraction       = 0.902;
RN.growth.drycloverDryMatterFraction        = 0.880;
RN.growth.drygrassDryMatterFraction         = 0.916;

RN.growth.alfalfaSilageDryMatterFraction    = 0.350;
RN.growth.cloverSilageDryMatterFraction     = 0.375;
RN.growth.grassSilageDryMatterFraction      = 0.395;
```

To convert from mass of dry matter to mass of fresh matter (as fed), we divide the mass of dry matter by the dry matter fraction:

$$Fresh\ matter\ (as\ fed) = \frac{Mass\ of\ dry\ matter}{Dry\ matter\ fraction}$$

Uncut pasture grass may have a water content of as much as 85%. Hence its dry matter fraction is 15%. When cutting grass for silage, the water content has to drop slightly in order for fermentation to occur. Typical water content when baling for silage is 60 - 65% meaning that the dry matter content is 35 - 40%.

For hay, much more water needs to evaporate before baling. Often the hay is tedded or left in the sun til the water content is 10-15% So the dry matter fraction of hay is 85 - 90%.

In Table 9, grass hay yield is at 51553 L/ha. However, tedding and windrowing each is set to have a loss of 5%, hence the actual windrow yield has dropped to 46397 L/ha. Assuming round bales of 1500 L and square bales of 2590 Liters, we will get 31 round bales per ha and almost 18 square bales per ha. For alfalfa we will get almost 20 round bales per ha and 11 square bales per ha, but this is for one out of three cuts per year (Table 10).

Table 9. Yield of hay per cut. 2 cuttings per year. Round bales = 1500 L, square bales = 2600 L.

```
DRYGRASS massPerLiter                     =        0.1800  kg/L
Yield randomness scaling                  =        1.0000
DRYGRASS base yield                       =        2.5776  L/sqm
DRYGRASS base yield                       =     25776      L/Ha
DRYGRASS no-plough loss                   =      3866      L/Ha
DRYGRASS no-weeding loss                  =      5155      L/Ha
DRYGRASS liming gain                      =      3866      L/Ha
DRYGRASS 1x fertilizing gain              =      4296      L/Ha
DRYGRASS max yield                        =     51553      L/Ha
DRYGRASS windrowLiterPerHa                =     46397      L/Ha
DRYGRASS round bales Per Ha               =       31.1392  Bales/Ha
DRYGRASS square bales Per Ha              =       17.9140  Bales/Ha
DRYGRASS seed Mass Per Liter              =        0.3100  kg/L
DRYGRASS seed Mass Per Ha                 =        8.5556  kg/Ha
DRYGRASS seed Volume Per Ha               =       27.5986  L/Ha
DRYGRASS seed Cost Per Liter              =        2.2320 €/L
DRYGRASS seed Cost Per Ha                 =       61.6000 €/Ha
DRYGRASS NPK Cost Per Ha                  =      228.6100 €/Ha
DRYGRASS Crop protection CostPerHa        =      154.0000 €/Ha
DRYGRASS Product costs Per Ha             =      444.2100 €/Ha
DRYGRASS price Per 1000 Liter             =       21      €/1000 L
DRYGRASS Gross income per ha - no loss    =      1073      €/Ha
DRYGRASS Net income per ha - no loss      =       628      €/Ha
```

Table 10. Yield of hay from alfalfa per cut. 3 cuttings per year. Round bales 1500 L , square bales 2600 L.

```
DRYLUCERNE massPerLiter                   =        0.1800  kg/L
Yield randomness scaling                  =        1.0000
DRYLUCERNE base yield                     =        1.6424  L/sqm
DRYLUCERNE base yield                     =     16424      L/Ha
DRYLUCERNE no-plough loss                 =      2464      L/Ha
DRYLUCERNE no-weeding loss                =      3285      L/Ha
DRYLUCERNE liming gain                    =      2464      L/Ha
DRYLUCERNE 1x fertilizing gain            =      2737      L/Ha
DRYLUCERNE max yield                      =     32849      L/Ha
DRYLUCERNE windrowLiterPerHa              =     29564      L/Ha
DRYLUCERNE round bales Per Ha             =       19.8416  Bales/Ha
DRYLUCERNE square bales Per Ha            =       11.4146  Bales/Ha
DRYLUCERNE seed Mass Per Liter            =        0.7370  kg/L
DRYLUCERNE seed Mass Per Ha               =       27.5000  kg/Ha
DRYLUCERNE seed Volume Per Ha             =       37.3134  L/Ha
DRYLUCERNE seed Cost Per Liter            =        4.4883 €/L
DRYLUCERNE seed Cost Per Ha               =      167.4750 €/Ha
DRYLUCERNE NPK Cost Per Ha                =      285.1000 €/Ha
DRYLUCERNE Crop protection CostPerHa      =       74.0000 €/Ha
DRYLUCERNE Product costs Per Ha           =      526.5750 €/Ha
DRYLUCERNE price Per 1000 Liter           =       21      €/1000 L
DRYLUCERNE Gross income per ha - no loss =       683      €/Ha
DRYLUCERNE Net income per ha - no loss    =       157      €/Ha
```

A new script is introduced, RealNumbersForageProductionCost.lua, which predicts the cost of bale production and compares with bale prices. For the example shown in Table 11, production cost exceeds sell price. The cost of production includes the fixed and variable cost of machinery used for making bales (mower, rake, tedder, baler, wrapper, twine, plastic wrap, fuel, etc.). More on equipment cost in a later chapter.

Table 11. Bale production cost.

Clover silage Mass Per Ha	=	20000	kg/ha
Clover silage Clover Bale Density	=	0.3900	€
Clover silage Clover Volume Per Ha	=	51282	L/ha
Clover silage Net Volume Per Ha	=	48718	L/ha
Clover silage Round Bale Volume	=	1490	L
Clover silage Square Bale Volume	=	2590	L
Clover silage Round Bale Mass	=	581	kg
Clover silage Square Bale Mass	=	1010	kg
Clover silage Round Bales Per Ha	=	32.6966	-
Clover silage Square Bales Per Ha	=	18.8100	-
Clover silage Income Per Ha	=	1242	€
Clover silage Round Bale Cost	**=**	**63.2793**	**€**
Clover silage Round Bale Price	**=**	**38.0000**	**€**
Clover silage Square Bale Cost	**=**	**88.8186**	**€**
Clover silage Square Bale Price	**=**	**65.0000**	**€**
Clover silage Price Per 1000L	=	25.5034	€/1000L
Clover silage Price Per 100kg	=	6.5393	€/100kg

5 Seed usage

The script **RealNumbersCropYield** also defines how much seed needs to be applied per area for seeded and planted crops. This depends both on the crop type and the season for seeding and planting.

Seed resellers often provide an equation for calculating the seed rate:

$$seedUsagePerHa = \frac{TSM(gram) \times plantsPerSqm\ (m^{-2})}{Germination\ percentage}$$

TSM means "thousand seed mass" and is entered in grams. As an example, lets us look at spring barley. $TSM = 30\ g, plantsPerSqm = 300, Germinatin\ percentage = 90\%$. Entering these numbers in the equation we get:

$$seedUsagePerHa = \frac{30\ g \times 300\ (m^{-2})}{90} = 100\frac{kg}{ha}$$

The volume of seed per hectare is obtained by dividing the mass by the density of the seed. Example data is shown in Table 3 and Table 4.

Seed usage depends on the germination percentage, a factor that varies considerably.

Table 12. Germination percentage.

	Seed bed preparation		
	Good	Average	Poor
Spring	95%	90%	80%
September	90%	85%	80%
October	85%	80%	75%

Seasons: Some tests have indicated that Seasons does not interfere with the seed usage defined in RealLifeNumbers.

Figure 6. Planting potatoes stored in root crop bunker (modified silage bunker). Oberlausitz map by RitchiF.

6 Crop sell prices

Mean crop sell-prices have been collected for a number of EU countries and USDA farming regions. Using the crop mass density these prices are converted to €/1000 L and used in the script **RealNumbersCropYield** to overwrite the default values. If one multiplies the crop sell price with the crop yield, we obtain crop income per hectare.

Table 13. Predicted income per hectare for a map assuming crop sell prices as in the UK.

```
BARLEY Gross income per ha - no loss     =      920     €/Ha
CANOLA Gross income per ha - no loss     =     1238     €/Ha
MAIZE Gross income per ha - no loss      =      845     €/Ha
OAT Gross income per ha - no loss        =      862     €/Ha
POTATO Gross income per ha - no loss     =     7970     €/Ha
RYE Gross income per ha - no loss        =      317     €/Ha
SOYBEAN Gross income per ha - no loss    =      848     €/Ha
SUGARBEET Gross income per ha - no loss  =     2222     €/Ha
SUNFLOWER Gross income per ha - no loss  =      726     €/Ha
WHEAT Gross income per ha - no loss      =     1411     €/Ha
```

Table 14. Predicted income per hectare for map assuming crop sell prices as in Germany.

```
BARLEY Gross income per ha - no loss     =     1007     €/Ha
CANOLA Gross income per ha - no loss     =     1294     €/Ha
MAIZE Gross income per ha - no loss      =     1638     €/Ha
OAT Gross income per ha - no loss        =      718     €/Ha
POTATO Gross income per ha - no loss     =     7071     €/Ha
RYE Gross income per ha - no loss        =      497     €/Ha
SOYBEAN Gross income per ha - no loss    =     1024     €/Ha
SUGARBEET Gross income per ha - no loss  =     1976     €/Ha
SUNFLOWER Gross income per ha - no loss  =      635     €/Ha
WHEAT Gross income per ha - no loss      =     1278     €/Ha
```

Table 15. Predicted income per hectare for a fruit map assuming crop sell prices as in US Heartland.

```
BARLEY Gross income per ha - no loss     =      687     €/Ha
CANOLA Gross income per ha - no loss     =      624     €/Ha
MAIZE Gross income per ha - no loss      =     1623     €/Ha
OAT Gross income per ha - no loss        =      503     €/Ha
POTATO Gross income per ha - no loss     =     9195     €/Ha
RYE Gross income per ha - no loss        =      494     €/Ha
SOYBEAN Gross income per ha - no loss    =     1251     €/Ha
SUGARBEET Gross income per ha - no loss  =      932     €/Ha
SUNFLOWER Gross income per ha - no loss  =      712     €/Ha
WHEAT Gross income per ha - no loss      =      775     €/Ha
```

Table 13, Table 14, and Table 15 illustrate the difference in crop income per hectare between UK, Germany and US Heartland.

The biggest income source among the standard fruits is potatoes. Despite the low selling price, sugarbeet is ranked second due to its high yield. This information must of course be compared with the cost of labor and equipment.

The redefined sell prices will only have their correct values when the economic difficulty level is set to HARD. Changing the economic difficulty level to Normal will scale the sell prices by a factor 1.8 and the Easy level will scale by a factor 3. The in-game sell price variation between sell points makes it difficult to see, if the specified sell-price is in effect. If there seems to a tendency that the mean sell-prices are higher than they should be, it is very likely that you are playing on a map, where the map maker has scaled sell prices for some of the map placeables.

Unfortunately, the in-game price variation between sell points is much too high, creating opportunities to sell at two times the national average. This may also create negative sell prices. A script has been added (RealNumbersSellingStations) which attempts to reduce the price variations. Whether this script has much effect has never been tested.

Seasons: I have not found any indication that Seasons interferes with the prices defined in RealLifeNumbers. Seasons defines the wages for helpers, about 1600 €/hour in day-time and 2500 €/hour in evening. If you are not happy with these numbers, you can change them in the Seasons mod. I set these wages to 16 €/hour and 25 €/hour, respectively.

7 Spraying

The script **RealNumbersSpraying** defines the spray rate of sprayers and spreaders for the following types of spray material: solid fertilizer, liquid fertilizer, slurry, manure, digestate, compost, lime, and herbicde. The purpose of applying fertilizers to a field is to add enough amounts of nutrients so that the field will hold enough nutrients to feed the next crop. Real-life farmers thus start by making soil tests to determine, how much nutrient is already present in the field.

Figure 7. Spreading manure on top of lime.

The applied amount should ideally only be the difference between how much nutrient, a crop need, and how much is already present. How much fertilizer to apply depends on the nutrient concentration of the fertilizer type used as well as the nutrient need of the crop.

7.1 Nutrient need in crops.

There is not yet a feature or a mod to manage the nutrient content in individual fields. Hence the present script only aims to replenish the amount removed from the field when the harvested crop is removed. The amount of nutrients removed by a certain crop can be looked up in tables. Typical values are listed in Table 16.

Table 16. Nutrient content removed from the field at harvest.

BARLEY	: N = 140.0 kg/ha,	P205 = 25.0 kg/ha,	K20 = 40.0 kg/ha
CABBAGE	: N = 90.0 kg/ha,	P205 = 90.0 kg/ha,	K20 = 90.0 kg/ha
CANOLA	: N = 224.0 kg/ha,	P205 = 24.0 kg/ha,	K20 = 120.0 kg/ha
CARROT	: N = 240.0 kg/ha,	P205 = 82.0 kg/ha,	K20 = 143.0 kg/ha
CLOVER	: N = 289.0 kg/ha,	P205 = 40.0 kg/ha,	K20 = 250.0 kg/ha
COFFEE	: N = 250.0 kg/ha,	P205 = 40.0 kg/ha,	K20 = 325.0 kg/ha
COTTON	: N = 150.0 kg/ha,	P205 = 112.0 kg/ha,	K20 = 75.0 kg/ha
DRYGRASS	: N = 170.0 kg/ha,	P205 = 23.0 kg/ha,	K20 = 70.0 kg/ha
GRASS	: N = 170.0 kg/ha,	P205 = 23.0 kg/ha,	K20 = 70.0 kg/ha
HEMP	: N = 110.0 kg/ha,	P205 = 80.0 kg/ha,	K20 = 140.0 kg/ha
HOPS	: N = 150.0 kg/ha,	P205 = 20.0 kg/ha,	K20 = 100.0 kg/ha
LETTUCE	: N = 140.0 kg/ha,	P205 = 45.0 kg/ha,	K20 = 230.0 kg/ha
MAIZE	: N = 140.0 kg/ha,	P205 = 61.0 kg/ha,	K20 = 36.0 kg/ha
MILLET	: N = 65.0 kg/ha,	P205 = 50.0 kg/ha,	K20 = 25.0 kg/ha
MUSTARD	: N = 90.0 kg/ha,	P205 = 22.0 kg/ha,	K20 = 65.0 kg/ha
OAT	: N = 114.0 kg/ha,	P205 = 22.0 kg/ha,	K20 = 60.0 kg/ha
OILSEEDRADISH	: N = 0.0 kg/ha,	P205 = 0.0 kg/ha,	K20 = 0.0 kg/ha
ONION	: N = 180.0 kg/ha,	P205 = 100.0 kg/ha,	K20 = 170.0 kg/ha
POPLAR	: N = 225.0 kg/ha,	P205 = 75.0 kg/ha,	K20 = 75.0 kg/ha
POPPY	: N = 50.0 kg/ha,	P205 = 75.0 kg/ha,	K20 = 75.0 kg/ha
POTATO	: N = 150.0 kg/ha,	P205 = 30.0 kg/ha,	K20 = 135.0 kg/ha
REDCABBAGE	: N = 90.0 kg/ha,	P205 = 90.0 kg/ha,	K20 = 90.0 kg/ha
RICE	: N = 450.0 kg/ha,	P205 = 180.0 kg/ha,	K20 = 100.0 kg/ha
RYE	: N = 150.0 kg/ha,	P205 = 22.0 kg/ha,	K20 = 70.0 kg/ha
SOYBEAN	: N = 0.0 kg/ha,	P205 = 45.0 kg/ha,	K20 = 0.0 kg/ha
SUGARBEET	: N = 209.0 kg/ha,	P205 = 41.0 kg/ha,	K20 = 299.0 kg/ha
SUGARCANE	: N = 136.0 kg/ha,	P205 = 50.0 kg/ha,	K20 = 100.0 kg/ha
SUNFLOWER	: N = 100.0 kg/ha,	P205 = 50.0 kg/ha,	K20 = 50.0 kg/ha
TOBACCO	: N = 224.0 kg/ha,	P205 = 145.0 kg/ha,	K20 = 202.0 kg/ha
WEED	: N = 0.0 kg/ha,	P205 = 0.0 kg/ha,	K20 = 0.0 kg/ha
WHEAT	: N = 209.0 kg/ha,	P205 = 24.0 kg/ha,	K20 = 70.0 kg/ha
Mean values	: N = 168.0 kg/ha,	P205 = 58.6 kg/ha,	K20 = 117.0 kg/ha

7.2 Nutrient content in fertilizer materials.

Seasons: The updated script assumes that each of the three fertilizer applications covers one third of the annual fertilizer amount.

Table 17. Nutrient content in organic and artificial fertilizers. (crop av. = crop available)

FERTILIZER	: N = 140.0 kg/Tonne,	P205 = 70.0 kg/Tonne,	K20 = 140.0 kg/Tonne
FERTILIZER crop av.	: N = 112.0 kg/Tonne,	P205 = 56.0 kg/Tonne,	K20 = 126.0 kg/Tonne
LIQUIDFERTILIZER	: N = 300.0 kg/Tonne,	P205 = 80.0 kg/Tonne,	K20 = 100.0 kg/Tonne
LIQUIDFERTILIZER crop av.	: N = 285.0 kg/Tonne,	P205 = 76.0 kg/Tonne,	K20 = 95.0 kg/Tonne
pigLIQUIDMANURE	: N = 3.6 kg/Tonne,	P205 = 1.5 kg/Tonne,	K20 = 2.2 kg/Tonne
pigLIQUIDMANURE crop av.	: N = 2.0 kg/Tonne,	P205 = 0.8 kg/Tonne,	K20 = 2.0 kg/Tonne
cowLIQUIDMANURE	: N = 2.6 kg/Tonne,	P205 = 1.2 kg/Tonne,	K20 = 2.5 kg/Tonne
cowLIQUIDMANURE crop av.	: N = 1.0 kg/Tonne,	P205 = 0.7 kg/Tonne,	K20 = 2.3 kg/Tonne
pigMANURE	: N = 7.0 kg/Tonne,	P205 = 6.0 kg/Tonne,	K20 = 8.0 kg/Tonne
pigMANURE crop av.	: N = 1.1 kg/Tonne,	P205 = 3.6 kg/Tonne,	K20 = 7.2 kg/Tonne
cowMANURE	: N = 6.0 kg/Tonne,	P205 = 3.2 kg/Tonne,	K20 = 9.4 kg/Tonne
cowMANURE crop av.	: N = 0.6 kg/Tonne,	P205 = 1.9 kg/Tonne,	K20 = 8.5 kg/Tonne
DIGESTATE	: N = 4.9 kg/Tonne,	P205 = 1.1 kg/Tonne,	K20 = 3.5 kg/Tonne
DIGESTATE crop av.	: N = 2.7 kg/Tonne,	P205 = 0.7 kg/Tonne,	K20 = 3.1 kg/Tonne
COMPOST	: N = 9.0 kg/Tonne,	P205 = 5.5 kg/Tonne,	K20 = 6.5 kg/Tonne
COMPOST crop av.	: N = 5.0 kg/Tonne,	P205 = 3.3 kg/Tonne,	K20 = 5.9 kg/Tonne

We will first determine the nutrient content in the fertilizers. This varies between slurry, manure and digestate and is also dependent on the animal producing the organic waste (Table 17). Only a fraction of the applied nutrients become available for crop absorption. The worst case is the nitrogen content in cow manure. It contains about 6 kg N per Tonne of manure, but only 10% is available for crop absorption. The majority evaporates to the atmosphere.

One sees clearly the labor advantage of artificial fertilizers, as they contain many times more nutrient per mass of fertilizer than organic sources. On the other hand, artificial fertilizer cannot supply the organic matter needed by the soil, hence manure and slurry should also be part of a fertilizer plan.

7.3 Amounts of fertilizer to be applied

The ratio of N, P, and K needed are different from the ratios in the fertilizer sources, hence it is not possible to meet the exact needs for N, P, and K. This would require specific fertilizer products containing only one of N, P, and K. Most countries have fertilizer acts regulating how much N, P, and K can be applied. Phosphate is typically the nutrient with the strictest limitation. The script then calculates a weighted amount of fertilizer to spray per hectare, by giving highest weight to the need for phosphate.

```
RN.Nweight    =      0.1;   -- weight for meeting nitrogen requirement
RN.Pweight    =       0.8;  -- weight for meeting phosphate requirement
RN.Kweight    =       0.1;  -- weight for meeting potassium requirement
```

The N, P, and K content of artificial fertilizer is calculated based on an NPK ratio of 14:7:14. This can be changed. Table 18 compares the spray rate for different fertilizer types and for a few crops.

Table 18. Spray rate for different fertilizer types and a few crop examples.

Abbreviations for fertilizer types:
Fert: Solid fertilizer
LiFe: Liquid fertilizer, diluted with water
PiMa: Pig manure
CoMa: Cow manure
PiLi: Pig liquid manure
CoLi: Cow liquid manure
Dige: Digestate
Comp: Compost
W : weighted application

		Fert	LiFe	PiMa	CoMa	PiLi	CoLi	Dige	Comp
BARLEY	: N: T/ha	0.42	0.08	44.44	77.78	23.57	44.87	17.32	9.43
BARLEY	: P: T/ha	0.15	0.05	2.31	4.34	11.11	11.57	12.63	2.53
BARLEY	: K: T/ha	0.11	0.07	1.85	1.58	6.73	5.93	4.23	2.28
BARLEY	: W: T/ha	0.17	0.06	6.48	11.41	11.92	14.34	12.26	3.19
BARLEY	: W: 1000 L/ha	0.21	0.07	10.80	19.01	13.24	15.93	13.62	3.84
BARLEY	: €/ha	72	53	137	206	129	112	181	86
		Fert	LiFe	PiMa	CoMa	PiLi	CoLi	Dige	Comp
CABBAGE	: N: T/ha	0.27	0.05	28.57	50.00	15.15	28.85	11.13	6.06
CABBAGE	: P: T/ha	0.54	0.20	8.33	15.63	40.00	41.67	45.45	9.09
CABBAGE	: K: T/ha	0.24	0.16	4.17	3.55	15.15	13.33	9.52	5.13
CABBAGE	: W: T/ha	0.48	0.18	9.94	17.85	35.03	37.55	38.43	8.39
CABBAGE	: W: 1000 L/ha	0.60	0.20	16.57	29.76	38.92	41.72	42.70	10.11
CABBAGE	: €/ha	202	162	209	322	380	294	567	227
		Fert	LiFe	PiMa	CoMa	PiLi	CoLi	Dige	Comp
CANOLA	: N: T/ha	0.67	0.13	71.11	124.44	37.71	71.79	27.71	15.08
CANOLA	: P: T/ha	0.14	0.05	2.22	4.17	10.67	11.11	12.12	2.42
CANOLA	: K: T/ha	0.32	0.21	5.56	4.73	20.20	17.78	12.70	6.84
CANOLA	: W: T/ha	0.21	0.08	9.44	16.25	14.32	17.85	13.74	4.13
CANOLA	: W: 1000 L/ha	0.27	0.08	15.74	27.08	15.92	19.83	15.26	4.98
CANOLA	: €/ha	90	69	199	293	155	140	203	112

It is seen that in order to cover a crop's need for nitrogen, a very large amount of organic fertilizer is needed.

The bottom line for each crop shows the cost of NPK applied. This is calculated based on the individual costs of N, P, and K. The prices for these are set in RealNumbersInitialization.lua.

Table 19. Cost of N, P, and K nutrients per kg.

```
RN.fertCostPerKg.N      = 0.87; -- €/kg DK: 0.87 €/kg; Ontario: 0.67 €/kg
RN.fertCostPerKg.P      = 1.47; -- €/kg DK: 1.47 €/kg; Ontario: 0.71 €/kg
RN.fertCostPerKg.K      = 0.67; -- €/kg DK: 0.67 €/kg; Ontario: 0.58 €/kg
```

The price of fertilizer nutrients varies greatly from country to country. Hence the mod user may want to change these costs to local values.

Take a look in the Nozzle catalogue from Hardy and you will see that spraying of herbicide and liquid fertilizer is almost a science in itself. Depending on the type of nozzle used many types of spray patterns can be achieved ranging from narrow streams to hollow and full cones. The amount of liquid fertilizer needed is assumed to be less than that for solid fertilizer, as the spray can be aimed more precisely, and nutrients come in closer contact with the plants. This is included in the script using the parameter (`RN.liqfertLiquidReductionFactor`).

Spray nozzles require a minimum volume flow rate to work properly. The ideal nozzle flow rate depends on the nozzle design and varies significantly among the enormous number of nozzle designs.

$$Broadcast\ spray\ rate\ \left(\frac{L}{ha}\right) = \frac{Nozzle\ flow\ rate\ \left(\frac{L}{min}\right) \times 600}{Speed\ (kph) \times Nozzle\ spacing\ (m)}$$

Most common nozzle spacings are 0.25m, 0.5 m, and 0.75 m.

For row crops, spraying fertilizer in narrow bands aligned with the crop rows reduces the waste of unused fertilizer. If the spray is banded rather than broadcasted, the treated area is less than the field area:

$$Treated\ area\ (ha) = \frac{Spray\ bandwidth\ (m)}{Nozzle\ spacing\ (m)} \times Field\ area\ (ha)$$

Band spraying thereby reduces the volume sprayed and the cost of fertilizer. To allow for this opportunity in the mod, we combine the two equations:

$$Banded\ spray\ rate\ \left(\frac{L}{ha}\right) = \frac{Spray\ bandwidth\ (m)}{Nozzle\ spacing\ (m)} \times Broadcast\ spray\ rate\ \left(\frac{L}{ha}\right)$$

If the spray rate is very low, there is a good change that the nozzle may not work optimally. This can be rectified by diluting the fertilizer with water, hence increasing the nozzle flow rate without applying too much fertilizer to the field. If a nozzle is available that can function properly at the required nozzle flow rate, then an option is to replace the nozzle with a type that matches the required flow rate.

Nozzle manufacturers publish tables matching nozzle types to field application rates. Hence our approach will be to estimate the lowest and highest field application rates and see, if nozzles are available for this range. Sunflower and wheat are examples of crops with low and high spray rates.

Table 20. Spray rates for a 30-8-10 liquid NPK fertilizer applied to wheat and sunflower.

					Wheat		Sunflower	
Concentration			1.301	kg/L	kg/ha	L/ha	kg/ha	L/ha
N	0.3	kg/kg	0.390	kg/L	240	615	60	154
P	0.08	kg/kg	0.104	kg/L	82	788	29	279
K	0.1	kg/kg	0.130	kg/L	143	1099	18	138

Table 20 shows that the spray rate for liquid fertilizer range from 138 to 1100 Liters/ha.

Table 21. Field application rates of liquid fertilizers for a given nozzle type[2].

		l/ha at km/h								
bar	l/min	4	5	6	7	8	9	10	12	16
1.0	1.86	558	446	372	319	279	248	223	186	139
1.5	2.28	683	546	455	390	341	303	273	228	171
2.0	2.63	788	631	526	451	394	350	315	263	197
3.0	3.22	966	773	644	552	483	429	386	322	241
4.0	3.72	1115	892	743	637	558	496	446	372	279
5.0	4.16	1247	997	831	712	623	554	499	416	312
		Large drop flat spray nozzle (371551) + 1553-20 Grey (370075)								

Table 21 show that we can obtain the range of field spray rate by adjusting the velocity of the tractor and by adjusting the nozzle spray rate. There is therefore no need to dilute liquid fertilizers.

Nevertheless, the script provides a parameter (`RN.liqfertDilutionFactor`) to set the dilution factor. In version 1.1.3 and later, `RN.liqfertDilutionFactor` = 1.

Each time you spray a field, you will have to look up the spray rate based on the crop type and the spray type. For cow manure on a barley field the spray rate in VariableSprayUsage should be set to $31\frac{m^3}{ha}$, while for pig manure it should be set to $18\frac{m^3}{ha}$. The log file contains similar information for all other fruit types on the map.

7.4 Lime application

Lime is spread to raise the pH of the soil. How much to spread depends on (1) how much the pH needs to be raised, (2) on the soil type, and (3) on the lime source. The script allows the user to define these parameters:

[2] http://hardi-international.com/sprayers/sprayer-components/nozzles

```
RN.soilType =          2;
RN.soilCurrentpH =     6;   -- determinant for lime application rate
RN.soilTargetpH =    6.7;   -- determinant for lime application rate
RN.limeNV =           50;   -- "Neutralizing Value, Ground limestone = 50
-- 1: Sands and loamy sands: 2: Sandy loams and silt loam; 3: Clay loams and clay
```

7.5 Herbicide application

Herbicides are sprayed to kill weeds. In this script, the default amount is 2 kg/ha, but this can be changed by the mod user. Herbicides are usually diluted with water and sprayed with a liquid fertilizer sprayer. In the script, the default dilution is set by the parameter:

```
RN.herbicideDilutionFactor = 200; -- 1 liter of herbicide to 200 liter of water
```

The price of herbicide is reduced accordingly. So, if you fill a sprayer with a tank of 2000 L, there is only 10 L of concentrated herbicide product in the tank. Your cost of filling the 2000 L tank with diluted herbicide then equals the cost of 10 L concentrated herbicide product (ignoring the cost of water).

A summary of spray rates is printed by pressing lAlt-ru:

Table 22. Summary of spray rates. Press lAlt-ru).

		Fert	LiFe	PiMa	CoMa	PiLi	CoLi	Dige	Comp
BARLEY	: W: 1000 L/ha	0.21	0.07	10.80	19.01	13.24	15.93	13.62	3.84
CABBAGE	: W: 1000 L/ha	0.60	0.20	16.57	29.76	38.92	41.72	42.70	10.11
CANOLA	: W: 1000 L/ha	0.27	0.08	15.74	27.08	15.92	19.83	15.26	4.98
CARROT	: W: 1000 L/ha	0.62	0.20	23.93	42.14	39.56	44.65	41.79	10.91
CLOVER	: W: 1000 L/ha	0.43	0.15	22.16	37.66	25.88	30.87	24.87	7.96
COFFEE	: W: 1000 L/ha	0.44	0.16	20.67	34.54	26.56	30.71	25.21	8.15
COTTON	: W: 1000 L/ha	0.75	0.24	22.34	40.31	48.46	52.67	53.22	12.64
DRYGRASS	: W: 1000 L/ha	0.22	0.07	12.37	21.52	13.58	16.67	13.48	4.10
GRASS	: W: 1000 L/ha	0.22	0.07	12.37	21.52	13.58	16.67	13.48	4.10
HEMP	: W: 1000 L/ha	0.56	0.19	16.78	29.62	36.28	39.14	39.07	9.64
HOPS	: W: 1000 L/ha	0.21	0.07	11.18	19.18	12.58	15.22	12.22	3.85
LETTUCE	: W: 1000 L/ha	0.40	0.14	14.74	24.89	24.70	27.29	24.83	7.10
MAIZE	: W: 1000 L/ha	0.43	0.14	15.22	27.32	27.39	30.68	29.73	7.32
MILLET	: W: 1000 L/ha	0.33	0.11	9.80	17.76	21.44	23.30	23.63	5.57
MUSTARD	: W: 1000 L/ha	0.19	0.06	7.98	13.85	11.59	13.33	11.88	3.32
OAT	: W: 1000 L/ha	0.19	0.06	9.21	16.04	11.95	14.10	12.15	3.48
OILSEEDRADISH	: W: 1000 L/ha	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ONION	: W: 1000 L/ha	0.72	0.24	23.18	40.93	46.05	50.36	49.37	12.36
POPLAR	: W: 1000 L/ha	0.55	0.18	21.74	38.69	35.24	40.11	37.64	9.64
POPPY	: W: 1000 L/ha	0.49	0.16	12.48	22.48	31.97	33.88	35.24	8.22
POTATO	: W: 1000 L/ha	0.28	0.09	12.68	21.72	17.18	19.91	17.12	5.06
REDCABBAGE	: W: 1000 L/ha	0.60	0.20	16.57	29.76	38.92	41.72	42.70	10.11
RICE	: W: 1000 L/ha	1.27	0.40	46.80	83.99	81.40	91.75	88.17	21.86
RYE	: W: 1000 L/ha	0.21	0.07	11.19	19.44	12.81	15.55	12.76	3.84
SOYBEAN	: W: 1000 L/ha	0.27	0.09	5.56	10.42	17.78	18.52	20.20	4.38
SUGARBEET	: W: 1000 L/ha	0.42	0.15	18.43	30.81	25.70	29.24	24.79	7.74
SUGARCANE	: W: 1000 L/ha	0.38	0.13	14.14	24.82	24.17	27.07	25.49	6.66
SUNFLOWER	: W: 1000 L/ha	0.35	0.11	11.85	21.16	22.56	24.96	24.41	6.02
TOBACCO	: W: 1000 L/ha	1.01	0.34	31.31	55.63	65.25	70.97	70.55	17.32
WEED	: W: 1000 L/ha	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WHEAT	: W: 1000 L/ha	0.24	0.07	14.56	25.37	14.70	18.47	14.47	4.51

Before starting the spreader/sprayer, (1) look up what crop is or will be in the field, (2) look up the application rate by pressing lAlt-ru, and (3) adjust the spray rate using the mod VariableSprayUsage.

8 Commodity prices

In Farming Simulator, the purchase price of farmland is very high. Much higher than in real life. The script **RealNumbersCommodityPrices** allows you to set the farmland price to a realistic value.

Taking a loan is easy in Farming Simulator. With a default interest rate of 300% it might not be easy to pay back the loan. The script sets the interest rate at 4% and a max loan amount to 3 mill. €. Both can easily be changed.

For some countries this information is confidential and therefore not included in EUROSTAT documents. The price per hectare varies considerably due to local differences in national laws (regulating foreign ownership), regional differences in climate and agricultural infrastructure as well as local variations in soil quality, drainage and terrain elevation.

8.1 Cost of common farm supplies

It is very common that farmers rent farmland from other farmers. While this is not a standard feature in Farming Simulator, it is accomplished in this script by assigning lower prices to some fields. The price for renting farmland in EU and USDA farming regions are listed in Table 24 and Table 25. In EU, the ratio of rent-to-purchase varies from 0.01 to about 0.05, with an average of 0.025, or 2.5% of the purchase price. This would be a good second guess if playing a map in a country where farmland rent prices is confidential.

Table 23. Purchase price for farmland in EU. €/ha.

	2011	2012	2013	2014	2015	2016	2017
Belgium							
Bulgaria	2112	2843	3175	3620	3891	4131	4622
Czech Republic	1836	3264	3662	4282	4775	5463	6462
Denmark	17476	17562	15708	17209	18752	17584	17328
Germany							
Estonia	1062	1265	1865	2426	2567	2735	2890
Ireland			26366	23449	23594	18141	19903
Greece	15393	14968	13907	13276	12633	12528	12627
Spain		12005	11910	12192	12574	12522	12827
France	5390	5440	5770	5940	6000	6070	6030
Croatia					2726	2835	3005
Italy	34257	39342	32532	39247	40153	28985	33538
Cyprus							
Latvia	2336	4475	4980	2552	2654	2917	2975
Lithuania	1212	1527	2009	2330	3089	3516	3571
Luxemburg	23648	24230	26621	27438	27738	26030	35590
Hungary	2089	2380	2709	3042	3356	4182	4368
Malta							
Netherland	50801	52716	54134	56944	61400	62972	68197
Austria							
Poland	4855	6080	6275	7723	9220	9083	9699
Portugal							
Romania	1366	1666	1653	2423	2039	1958	2085
Slovenia			15545	16009	16071	17136	16876
Slovakia							
Finland	8210	8047	8461	8090	8138	8326	8718
Sweden	6811	7043	6797	7408	7751	7921	8708
United Kingdom	18885	21905	23283	26634	30464	25999	23450

Table 24. Rent price per year in EU. €/ha.

	2011	2012	2013	2014	2015	2016	2017
Belgium							
Bulgaria	153	174	194	210	215	225	240
Czech Republic	56	61	66	73	87	96	104
Denmark	534	562	555	535	518	536	539
Germany							
Estonia	26	35	40	48	52	52	58
Ireland			258	255	269	290	295
Greece	549	544	460	435			
Spain		134	136	138	140	144	148
France	139	145	155	167	184	202	215
Croatia			73	67	73	74	69
Italy							
Cyprus							
Latvia	57	67	71	38	43	46	57
Lithuania	56	66	78	80	80	81	99
Luxembourg				220	233	240	244
Hungary	107	126	129	131	139	151	160
Malta							
Netherlands	624	653	683	720	749	794	847
Austria	260	264	270	276	281	285	288
Poland							
Portugal							
Romania							
Slovenia							
Slovakia	37	37	39	44	44	50	
Finland	191	213	210	223	225	226	229
Sweden	168	176	180	174	160	160	
United Kingdom	214	238	212	237	245	224	

Table 25. Rent prices on farmland in USDA regions. $/ha. Averaged over 2016--2018.

USDA Regions	$/ACRE	$/ha
Delta Region	97	240
Eastern Mountain Region	87	214
Great Lakes Region	157	388
Heartland Region	156	386
Mountain Region	97	239
North Eastern Region	81	200
Northern Plains Region	96	238
Northwest Region	170	421
Pacific Region	267	659
Southern Plains Region	37	91
Southern Region	96	236
Upper Midwest Region	180	444
US average	**127**	**313**

The parameters for purchasing and renting farmlands are defined in **RealNumbersInitialization**.

```
RN.pricePerHa                     =      25000; -- GEO DE, €/hectare
RN.rentPricePerHa                 = 0.025 * RN.pricePerHa;-- €/hectare
RN.gameDayOfYearRentTerminates    = 1;
RN.rentedFields      =  { 3,  5,  7,  9, 11, 13, 15, 17, 21, 23, 25, 29,
                         31, 33, 35, 37, 41, 43, 45, 47, 51, 53, 55, 57,
                         61, 63, 65, 67, 71, 73, 75, 77, 81, 83, 85, 87};
```

The list of rentable farmlands can be changed. I have randomly chosen farmlands to be rentable. The list can be extended or shortened as desired. Notice, the variable is called RN.rentedFields. In reality it is rented farmland. Hence the numbers do not match field numbers. Press lAlt-rf or lAlt-rt to get a list of fields or farmlands, and see in these lists, which fields can be rented.

The purchase price of a few commodities is listed in Table 26. At lot more is included. Herbicide and fertilizers are expensive. For herbicide, the purchase price of pure substance has been reduced by typical sprayer dilution factors as mentioned in the section on spraying.

A small random day-by-day variation is installed in commodity prices:

```
RN.commodityPriceVariation = 10;    -- price fluctuation in percentage
```

Table 26. Example commodity prices (Germany).

```
Annual interest rate                        =       4     %
Max loan                                    =   3000000   €
Farmland purchase price Per Ha              =   25000     €/ha
Farmland rent price Per Ha                  =     625     €/ha

APFEL fillTypeIndex                         =      99
APFEL massPerLiter                          =      0.3000  kg/L
RandomPriceFactor                           =      0.9990
APFEL price                                 =     152     €/1000 L

BIRNE fillTypeIndex                         =     102
BIRNE massPerLiter                          =      0.3000  kg/L
RandomPriceFactor                           =      0.9622
BIRNE price                                 =     165     €/1000 L

CHAFF fillTypeIndex                         =      21
CHAFF massPerLiter                          =      0.1750  kg/L
RandomPriceFactor                           =      0.9551
CHAFF price                                 =      40     €/1000 L

COMPOST fillTypeIndex                       =      92
COMPOST massPerLiter                        =      0.6000  kg/L
RandomPriceFactor                           =      1.0210
COMPOST price                               =      30     €/1000 L

DIESEL fillTypeIndex                        =      32
DIESEL massPerLiter                         =      0.8400  kg/L
RandomPriceFactor                           =      1.0263
DIESEL price                                =     940     €/1000 L

DIGESTATE fillTypeIndex                     =      47
DIGESTATE massPerLiter                      =      0.9000  kg/L
RandomPriceFactor                           =      0.9686
DIGESTATE price                             =       3     €/1000 L

ERDE fillTypeIndex                          =      96
ERDE massPerLiter                           =      0.3900  kg/L
RandomPriceFactor                           =      0.9507
ERDE price                                  =     190     €/1000 L

FERTILIZER fillTypeIndex                    =      43
FERTILIZER massPerLiter                     =      0.8000  kg/L
RandomPriceFactor                           =      1.0254
FERTILIZER price                            =     388     €/1000 L
```

The purchase price of store commodities, such as bales, big bags and pallets are reduced to values typical for the country/USDA region, and the prices are made to fluctuate randomly. For this reason, there will be small differences in the prices of round and square bales.

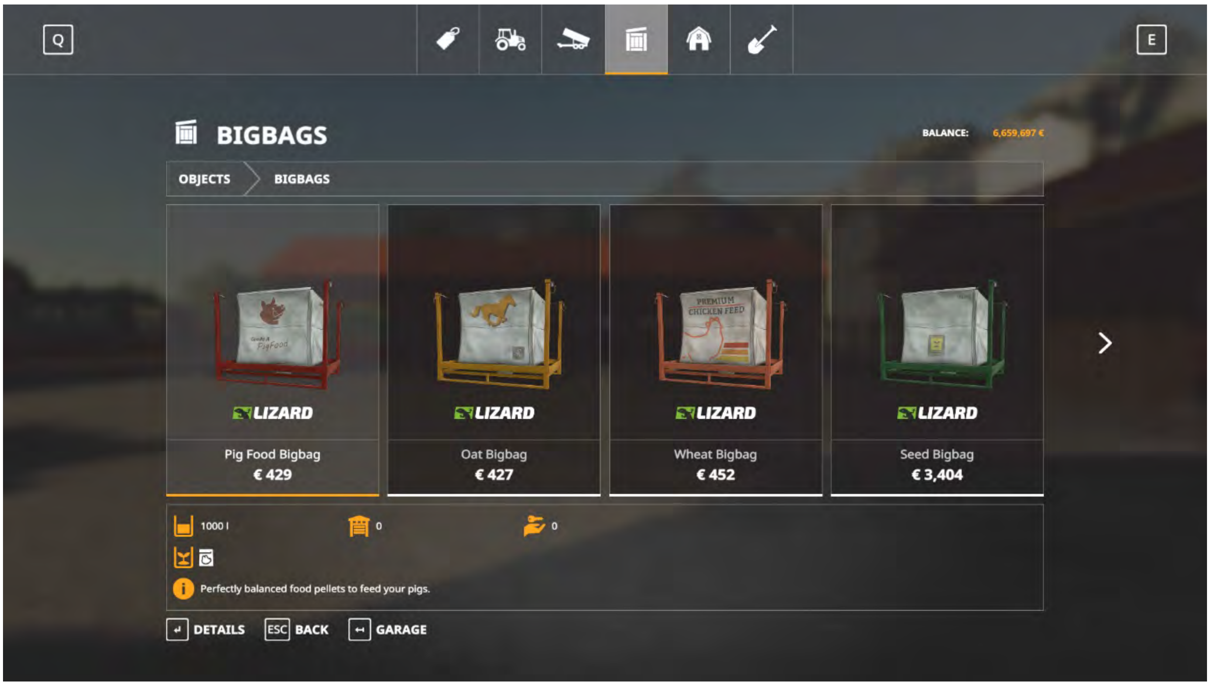

Figure 8. Modified store prices on pallets.

Figure 9. Not everything costs money. Sometimes you are lucky. Oberlausitz map by RitchiF.

8.2 Some running costs.

Some daily running costs can now be adjusted. **Vehicle Running Cost** is controlled by the three mod parameters:

```
RN.maintenanceCostPercentage              = 0.5;
RN.heavyUseMaintenanceFactor              = 1.5;
RN.equipmentInsurancePercentage           = 0.2;
```

The first factor sets the running cost to 0.5% of the total money value of owned equipment (vehicles, trailers, implements, tools, etc.). In case an item is used more than 3 hours per day, the cost is scaled by a factor 1.5 (50% more than base cost). Insurance costs are added to this cost. It is set to 0.2% of the total value of the equipment. The mod calculates the total annual cost and divides by the number of game days per year.

Property Maintenance Cost can also be adjusted. It is controlled by the parameter:

```
RN.propertyMaintenanceCostPercentage      = 0.5;
```

The mod sums up the total value of buildings, silos, placeables etc. and sets the annual maintenance cost at 0.5%. To set the cost per game day, the mod divides the annual cost by the number of game days per year. For this to work the mod sets the in-game parameter dailyUpkeep = 0.

There is also a **daily cost of animal upkeep**. The annual upkeep per animal is obtained slightly different for the different animals due to different principles used in the data sources.

PIGS:

```
RN.variableCost["PIG"]              = 0.324;     -- GEO - DE, € per kg carcas
RN.labourCost["PIG"]                = 0.156;     -- GEO - DE, € per kg carcas
RN.financeCost["PIG"]               = 0.252;     -- GEO - DE, € per kg carcas
RN.carcasWeight["PIG"]              = 94;        -- GEO - DE, kg
RN.liveSlaughterWeight["PIG"]       = 122;       -- GEO - DE, kg
RN.annualUpkeepPerAnimal["PIG"]   = RN.carcasWeight["PIG"] *
(RN.variableCost["PIG"]+RN.labourCost["PIG"]+RN.financeCost["PIG"]);
```

For pigs, the cost parameters are based of carcass weight. The costs exclude feed and water, but includes health and veterinary services, labor cost and finance costs (unknown type).

COWS:

```
RN.variableCost["COW"]              = 45;        -- GEO - UK, €
RN.labourCost["COW"]                = 175;       -- GEO - UK, €
RN.financeCost["COW"]               = 0;         -- GEO - UK, €
RN.annualUpkeepPerAnimal["COW"]   =
(RN.variableCost["COW"]+RN.labourCost["COW"]+RN.financeCost["COW"]);
```

For cows the cost is based on rearing heifers until 1 year old.

SHEEP:

```
RN.variableCost["SHEEP"]            = 21;        -- GEO - US, €
RN.labourCost["SHEEP"]              = 10;        -- GEO - US, €
RN.financeCost["SHEEP"]             = 5;         -- GEO - US, €
RN.annualUpkeepPerAnimal["SHEEP"]       =
(RN.variableCost["SHEEP"]+RN.labourCost["SHEEP"]+RN.financeCost["SHEEP"]);
```

To get an overview of running costs press lAlt-re:

Table 27. Annual costs of equipment, property and animal upkeep. Press lAlt-re

Total value of equipment	=	2554599	€
Total maintenance of equipment	=	17882	€/year
Total value of properties	=	3139500	€
Total maintenance of properties	=	15698	€/year
Total animal upkeep	=	8613	€/year

To get an overview of the current number of animals, animal upkeep costs, and required hectares for feed, press lAlt-ra. The required hectares for feed depend on crop yield and will vary depending on the geographic location of the map and how well the crop is tended to.

Table 28. Number of animals and their upkeep cost and hectare requirements. Press lAlt-ra

Current number of cows	=	80	
Annual upkeep: cows	=	17600	€/year
Straw hectares	=	30.7765	Ha
Hay hectares	=	8.5276	Ha
Silage hectares	=	3.7740	Ha
Current number of pigs	=	20	
Annual upkeep: pigs	=	604	€/year
Wheat hectares	=	12.9781	Ha
Maize hectares	=	9.8925	Ha
Soybean hectares	=	17.1265	Ha
Straw hectares	=	16.2664	Ha
Current number of sheep	=	100	
Annual upkeep: sheep	=	3600	€/year
Hay hectares	=	1.0541	Ha
Grass hectares	=	0.9330	Ha
Current number of chickens	=	11	
Annual upkeep: chickens	=	110	€/year
Current number of horses	=	1	
Annual upkeep: horses	=	200	€/year

Notice that the upkeep of animals will increase gradually when mature animals start giving birth.

Figure 10. Adjusted vehicle running/leasing costs, property maintenance, and animal upkeep.

9 Leasing equipment

The cost of leasing equipment is very high in Farming Simulator. The in-game default cost is divided into three components, all percentages of the purchase price: a 2% lease initiation fee, 1 % daily fee, and an hourly fee of 2.1%. Let us consider as an example that we have 4 ha of sugar beet to harvest. According to Table 13, the crop income will be from 4,000 to 8,000 € depending on your map location. Let us assume that we can harvest the field within 2 hours if we use the big Holmer self-propelled sugar beet harvester. It costs about 500,000 €, hence the cost of leasing for two hours will be (2+2.1+2.1+1= 7.2%) 36,000 €, much higher than the expected real-life harvest income. In Denmark, the rate of hiring a contractor for beet harvesting is about 290 €/ha.

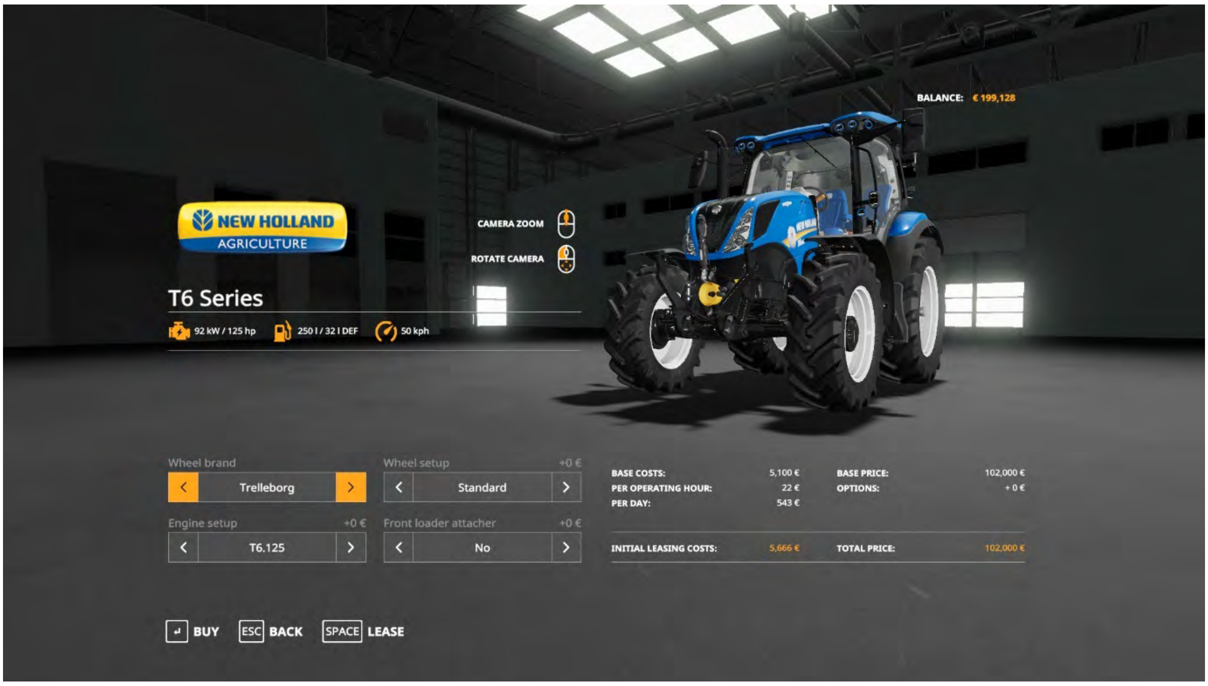

Figure 11. Reduced leasing cost on tractor.

The script **RealNumbersLeasing.lua** presents the mod user with the option of choosing different models for long-term and short-term leasing. By long-term leasing we understand a situation where the farmer leases equipment as an alternative to buying. By short-term leasing we understand day-by-day leasing, where it resembles hiring a contractor to seed or harvest your fields.

For long-term leasing the user has the option of designing their own leasing contracts (see Figure 11 and Table 29).

Table 29. Equipment leasing contract. (Long term leasing)

Contract parameters			Contract items	Value
Equipment lifetime (years)	6		Equipment value (example)	100000
Equipment lifetime (months)	72		End time value	37715
Annual value loss factor	0.15		Initial installment	5000
Annual Interest factor	0.05		Base loan	57285
Initial installment factor	0.05		Loan interest	19482
Calculated values			Total loan	76767
Per gameday pay factor	0.5331		Installment per gameday	533
Per gamehour pay factor	0.0222		Installment per gamehour	22

The contract example shown in Table 29 has a 5% initial installment. This may produce realistic values for a long-term lease but will make the cost very high in the case of a “one-day” lease.

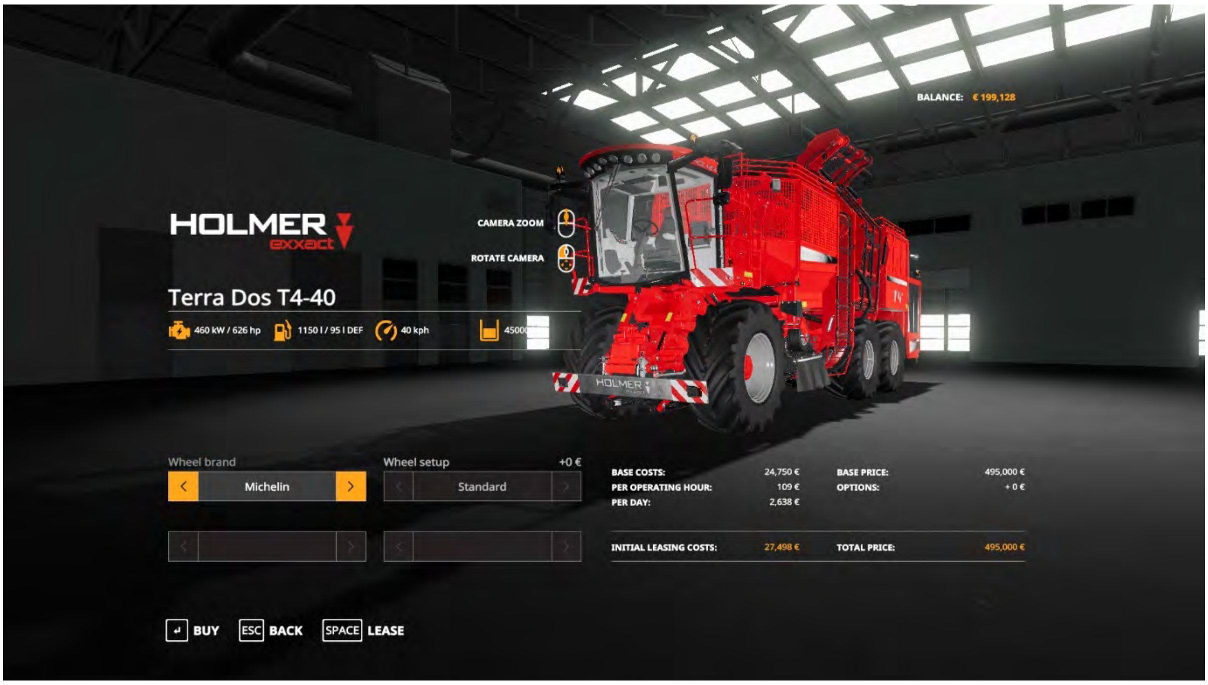

Figure 12. Reduced lease on sugar beet harvester.

Figure 13. A dealer with equipment on display. Felsbrunn map.

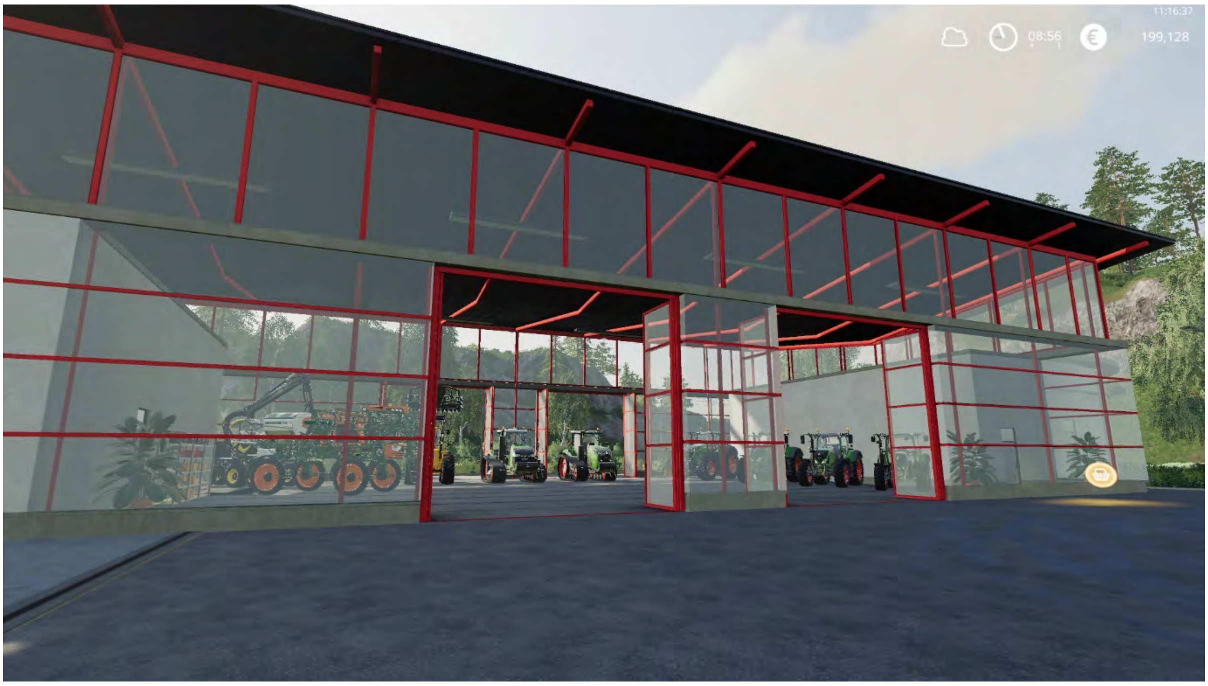

Figure 14. No cardboard tractors at this dealer. Felsbrunn.

The objective of RealNumbersLeasing is to make leasing a viable alternative to buying. The leasing model presented above is useful for long-term leasing. For day-by-day leasing the deposit and daily lease is much too high.

As mentioned earlier, day-by-day leasing of special equipment, such as harvesters, can be interpreted as hiring a contractor. Putting a helper on the leased equipment completes this role play. Large-scale root-crop farmers often hire a contractor to harvest their root crop. The farmer may assist by carting the crops to storage.

In a later chapter, we will investigate the cost of buying equipment and compare with the cost of hiring a contractor.

Personally, I enjoy maps with multifruits, in particular vegetable crops. In this case, you would need to rent different headers for each vegetable crop, which would be very expensive using the long-term lease model.

Consequently, the mod user who wants to lease equipment on a day-by-day basis will have to use a short-term lease model. This is done by setting the parameter RN.leaseMode to zero in the script RealNumbersInitialization.lua.

```
RN.leaseMode = 0;

RN.leasePerHourScale  = 1.0;  -- Scales the lease per hour (default = 1)
```

These parameters are used in the script RealNumbersLeasing.lua to scale the per day leasing factor and the deposit factor.

If you prefer long-term leasing, set `RN.leaseMode = 1.`

Unfortunately, the same lease per hour scale factor must be used for all equipment. Hence the lease cost is a fixed fraction of the purchase price and cannot be set individually for each piece of equipment.

When doing day-by-day leasing, the game time scale should be set to one. If not, you get less work done for the same cost.

Figure 15. Home delivery?!?

10 Animal products

Sell prices for animal products (milk, wool and egg) have been obtained for EU countries and USDA agricultural regions. These prices are defined in the script **RealNumbersAnimalProducts**. Output to the log file is shown in Table 30. Random price variation is active.

Wool density is based on wool bales of 480 L and 180 kg yielding 0.375 kg/L. Egg density is based on 60 gram per egg and a package volume of 1.4 L per six eggs, yielding 0.257 kg/L.

Table 30. Sell prices for animal products (Germany).

MILK massPerLiter	=	1.0250	kg/L
MILK pricePer1000Liter	=	322	€/1000 L
WOOL massPerLiter	=	0.3750	kg/L
WOOL pricePer1000Liter	=	2498	€/1000 L
EGG massPerLiter	=	0.2570	kg/L
EGG pricePer1000Liter	=	408	€/1000 L

Figure 16. Off to the spinnery. Felsbrunn.

11 Animal care

Seasons: A new script replaces the old AnimalCare script. It allows the user to adjust parameters for feed intake and waste output, but not the growth rate.

The present chapter provides typical data for growth and consumption of feed, water, straw, etc. Table 31 shows the typical number of animals on farms in different EU member states. Useful information if you want to set up an "average farm" in a specific country.

Table 31. Average number of animals on EU farms in 2015.

Country	Farms	Total animals	Dairy cows	Other cattle	Sheep and goats	Pigs	Poultry
(BEL) Belgium	29140,00	128,79	18,42	46,35	0,74	51,43	11,51
(BGR) Bulgaria	114420,00	11,79	2,64	2,60	2,55	2,00	1,92
(CYP) Cyprus	10470,00	8,55	1,81	0,86	3,62	0,58	1,68
(CZE) Czech Republic	17210,00	91,51	21,96	38,63	1,04	19,41	9,97
(DAN) Denmark	28330,00	144,96	20,83	21,38	0,51	95,28	6,42
(DEU) Germany	187460,00	89,55	23,19	26,12	0,68	36,17	2,71
(ELL) Greece	346580,00	6,01	0,13	1,06	4,48	0,08	0,24
(ESP) Spain	417830,00	32,22	2,26	6,77	5,13	14,27	3,64
(EST) Estonia	7620,00	39,62	13,63	15,33	1,24	7,48	1,63
(FRA) France	298110,00	72,51	12,78	32,22	3,24	10,76	13,24
(HRV) Croatia	81460,00	9,11	1,91	1,99	1,83	1,82	1,35
(HUN) Hungary	102100,00	20,81	2,63	3,28	1,40	8,08	5,26
(IRE) Ireland	86380,00	58,67	13,96	38,95	5,31	0,09	0,03
(ITA) Italy	532660,00	19,88	3,10	5,34	1,56	6,25	3,49
(LTU) Lithuania	61710,00	11,98	4,69	5,02	0,24	1,60	0,36
(LUX) Luxembourg	1600,00	112,70	29,12	65,16	0,54	17,36	0,23
(LVA) Latvia	24680,00	21,54	6,84	7,17	0,30	6,93	0,23
(MLT) Malta	2830,00	16,24	2,52	2,04	0,56	6,75	4,27
(NED) Netherlands	49520,00	135,16	33,04	25,30	2,78	50,52	22,87
(OST) Austria	91290,00	24,45	6,12	8,64	0,54	7,32	1,58
(POL) Poland	735170,00	12,09	3,07	3,37	0,08	3,78	1,67
(POR) Portugal	97690,00	15,08	2,01	6,75	3,14	0,51	2,57
(ROU) Romania	1133230,00	4,57	1,37	0,56	1,65	0,57	0,31
(SUO) Finland	36630,00	30,03	8,00	9,84	0,25	8,96	2,80
(SVE) Sweden	27990,00	76,04	13,77	27,64	0,97	23,76	9,56
(SVK) Slovakia	3650,00	143,09	38,08	57,43	10,39	20,15	16,74
(SVN) Slovenia	43930,00	9,96	2,28	5,09	0,41	1,37	0,58
(UKI) United Kingdom	97580,00	135,50	18,41	51,27	30,78	17,55	16,79
Average		52,94	11,02	18,43	3,07	15,03	5,13

11.1 Animal growth data

Using Seasons 19, animal growth rate is controlled by a set of growth parameters unique to each animal type and breed. FS19_RealLifeNumbers does not modify these growth parameters. In the following tables are listed example growth data for the different animal types. These numbers are taken from the internet and may not agree 100% with the growth rate set up by Seasons 19.

Table 32. Weight chart for pigs.

	weeks	Weight kg	Water L/day	Accum L/pig	Feed kg/day	Accum kg/pig	Gain kg/day	Manure kg/day	Manure kg/week	Accum kg/pig
	1	2.27						0.13	0.92	0.9
Creep	2	3.63						0.22	1.53	2.5
	3	6						0.37	2.61	5.1
	4	7.5	0.90	6	0.25	1.8	0.25	0.47	3.30	8.4
	5	9.5	1.40	16	0.41	4.6	0.35	0.60	4.21	12.6
	6	13	1.90	29	0.58	8.7	0.45	0.83	5.80	18.4
	7	17	2.20	45	0.74	13.8	0.57	1.09	7.62	26.0
	8	21	2.50	62	0.9	20.1	0.69	1.35	9.44	35.4
Growers	9	28	2.75	82	1.1	27.8	0.73	1.80	12.63	48.1
	10	34	3.00	103	1.2	36.2	0.77	2.19	15.36	63.4
	11	41	3.30	126	1.5	46.7	0.80	2.65	18.55	82.0
	12	47	3.60	151	1.5	57.2	0.84	3.04	21.28	103.2
Finishers	13	54	3.90	178	1.7	69.1	0.87	3.50	24.47	127.7
	14	61	4.20	208	1.9	82.4	0.90	3.95	27.65	155.4
	15	67	4.50	239	2.1	97.1	0.93	4.34	30.38	185.8
	16	74	4.80	273	2.2	112.5	0.96	4.80	33.57	219.3
Slaughter	17	81	5.15	309	2.4	129.3	0.98	5.25	36.76	256.1
	18	88	5.50	347	2.6	147.5	1.01	5.71	39.94	296.0
	19	94	5.75	387	2.8	167.1	1.03	6.10	42.68	338.7
	20	101	6.00	429	3.1	188.8	1.05	6.55	45.86	384.6
	21	108	6.30	474	3.3	211.9	1.07	7.01	49.05	433.6
	22	115	6.60	520	3.5	236.4	1.08	7.46	52.24	485.8
	23	122	6.90	568	3.7	262.3	1.09	7.92	55.42	541.3
	24	129	7.20	618	3.9	289.6	1.10	8.37	58.61	599.9
	25	137	7.73	673	4.09	318.2	1.10	8.89	62.25	662.1
	26	145	8.11	729	4.31	348.4	1.10	9.41	65.89	728.0
Sows		180	17.50	3150.0	3.3	592.0		11.69	81.83	2104.0

Table 33. Weight chart for cows. DM: Dry matter.

Month	Holstein lb	Weight kg	Water L/day	Accum L/animal	Gain kg/day	Energy need MJ/day	Feed DM kg/kg BW	Feed DM kg/day	Manure kg/day	Accum kg/animal
0	90	41		0	0.4	7.9			3.0	91.0
1	119	54	6	180	0.44	19.6	Milk + Milk replacer and grain starter mix		4.1	214.6
2	161	73	7.5	405	0.64	24.6			5.7	385.1
3	211	96	9.25	683	0.76	30.1			7.6	611.7
4	258	117	12.3	1052	0.71	35.0			9.3	890.9
5	311	141	14.4	1484	0.80	40.3			11.3	1229.5
6	369	167	15.8	1958	0.88	45.8		0.00	13.5	1633.0
7	422	192	17.1	2472	0.80	50.7	0.033	6.32	15.4	2095.9
8	468	212	18.3	3020	0.70	54.8	0.033	7.01	17.1	2610.3
9	530	241	19.8	3614	0.94	60.1	0.033	7.94	19.5	3194.2
10	575	261	20.9	4241	0.68	63.9	0.033	8.61	21.1	3828.4
11	638	290	22.5	4915	0.95	69.1	0.033	9.56	23.5	4533.2
12	682	310	23.5	5621	0.67	72.6	0.033	10.22	25.1	5287.4
13	728	330	24.7	6361	0.70	76.3	0.033	10.91	26.9	6093.0
14	776	352	25.9	7137	0.73	80.0	0.033	11.62	28.6	6952.4
15	843	383	27.5	7962	1.01	85.1	0.033	12.63	31.1	7886.8
16	913	414	29.2	8839	1.06	90.4	0.033	13.68	33.8	8899.6
17	931	423	29.7	9729	0.27	91.7	0.033	13.95	34.4	9932.6
18	969	440	30.6	10648	0.57	94.5	0.033	14.52	35.9	11008.2
19	1007	457	31.5	11594	0.57	97.3	0.033	15.08	37.3	12126.3
20	1050	477	32.6	12572	0.65	100.4	0.033	15.73	38.9	13292.6
21	1100	499	33.8	13587	0.76	103.9	0.033	16.48	40.7	14514.9
22	1150	522	35.1	14639	0.76	107.5	0.033	17.23	42.6	15793.2
23	1200	545	36.3	15728	0.76	111.0	0.033	17.98	44.5	17127.5
Cows	Annual	640	102	37156			0.026	16.90	52.3	18833.0

Table 34. Sheep growth and feed intake.

	Merino ram					Dorset wethers				
Weeks	Feed kg/week	Accum kg	Weight kg	Weight gain kg/week	Gain/feed kg/kg	Feed kg/week	Accum kg	Weight kg	Weight gain kg/week	Gain/feed kg/kg
1	1.08	1.08	5.71	0.50	0.46	0.84	0.84	4.96	0.36	0.43
2	2.11	3.2	6.21	0.73	0.35	1.64	2.5	5.32	0.53	0.32
3	3.08	6.3	6.94	0.94	0.30	2.40	4.9	5.85	0.68	0.28
4	4.00	10.3	7.88	1.13	0.28	3.12	8.0	6.53	0.82	0.26
5	4.87	15.1	9.01	1.31	0.27	3.80	11.8	7.35	0.95	0.25
6	5.68	20.8	10.32	1.47	0.26	4.44	16.2	8.31	1.07	0.24
7	6.46	27.3	11.78	1.61	0.25	5.05	21.3	9.38	1.18	0.23
8	7.19	34.5	13.39	1.74	0.24	5.63	26.9	10.56	1.28	0.23
9	7.88	42.3	15.13	1.85	0.23	6.17	33.1	11.84	1.37	0.22
10	8.53	50.9	16.97	1.94	0.23	6.69	39.8	13.21	1.44	0.22
11	9.14	60.0	18.92	2.03	0.22	7.17	46.9	14.65	1.51	0.21
12	9.71	69.7	20.95	2.10	0.22	7.63	54.6	16.16	1.56	0.21
13	10.26	80.0	23.04	2.15	0.21	8.06	62.6	17.72	1.61	0.20
14	10.77	90.7	25.19	2.20	0.20	8.47	71.1	19.33	1.65	0.20
15	11.25	102.0	27.39	2.23	0.20	8.85	79.9	20.99	1.68	0.19
16	11.70	113.7	29.62	2.26	0.19	9.21	89.2	22.67	1.71	0.19
17	12.12	125.8	31.88	2.27	0.19	9.55	98.7	24.38	1.73	0.18
18	12.51	138.3	34.15	2.28	0.18	9.87	108.6	26.11	1.74	0.18
19	12.89	151.2	36.43	2.28	0.18	10.16	118.7	27.84	1.74	0.17
20	13.23	164.4	38.71	2.27	0.17	10.44	129.2	29.59	1.74	0.17
21	13.56	178.0	40.98	2.25	0.17	10.70	139.9	31.33	1.74	0.16
22	13.86	191.9	43.23	2.23	0.16	10.94	150.8	33.07	1.73	0.16
23	14.14	206.0	45.46	2.21	0.16	11.17	162.0	34.80	1.72	0.15
24	14.41	220.4	47.67	2.18	0.15	11.38	173.4	36.52	1.70	0.15
25	14.65	235.1	49.85	2.15	0.15	11.57	185.0	38.23	1.68	0.15
26	14.88	249.9	52.00	2.11	0.14	11.75	196.7	39.91	1.66	0.14
27	15.09	265.0	54.11	2.07	0.14	11.92	208.6	41.57	1.64	0.14
28	15.28	280.3	56.18	2.03	0.13	12.07	220.7	43.21	1.61	0.13
29	15.46	295.8	58.21	1.99	0.13	12.21	232.9	44.82	1.58	0.13
30	15.62	311.4	60.20	1.94	0.12	12.34	245.3	46.40	1.55	0.13
31	15.77	327.1	62.14	1.90	0.12	12.46	257.7	47.95	1.52	0.12
32	15.91	343.1	64.04	1.85	0.12	12.56	270.3	49.47	1.49	0.12
33	16.04	359.1	65.89	1.80	0.11	12.66	282.9	50.96	1.46	0.11
34	16.15	375.2	67.69	1.75	0.11	12.74	295.7	52.42	1.42	0.11
35	16.25	391.5	69.44	1.70	0.10	12.81	308.5	53.84	1.39	0.11
36	16.34	407.8	71.14	1.65	0.10	12.88	321.4	55.22	1.35	0.11
37	16.42	424.3	72.79	1.61	0.10	12.94	334.3	56.58	1.32	0.10
38	16.49	440.7	74.40	1.56	0.09	12.99	347.3	57.89	1.28	0.10
39	16.56	457.3	75.96	1.51	0.09	13.03	360.3	59.18	1.25	0.10
40	16.61	473.9	77.46	1.46	0.09	13.06	373.4	60.43	1.21	0.09
41	16.65	490.6	78.93	1.42	0.08	13.08	386.4	61.64	1.18	0.09
42	16.69	507.3	80.34	1.37	0.08	13.10	399.6	62.82	1.15	0.09
43	16.72	524.0	81.71	1.32	0.08	13.11	412.7	63.96	1.11	0.08
44	16.74	540.7	83.04	1.28	0.08	13.12	425.8	65.07	1.08	0.08
45	16.76	557.5	84.32	1.24	0.07	13.12	438.9	66.15	1.05	0.08
46	16.77	574.2	85.55	1.20	0.07	13.11	452.0	67.20	1.01	0.08
47	16.77	591.0	86.75	1.15	0.07	13.10	465.1	68.21	0.98	0.08
48	16.77	607.8	87.90	1.11	0.07	13.08	478.2	69.20	0.95	0.07
49	16.76	624.5	89.02	1.08	0.06	13.06	491.2	70.15	0.92	0.07
50	16.75	641.3	90.09	1.04	0.06	13.03	504.3	71.07	0.89	0.07
51	16.73	658.0	91.13	1.00	0.06	13.00	517.3	71.96	0.86	0.07
52	16.70	674.7	92.13			12.96	530.2	72.83		

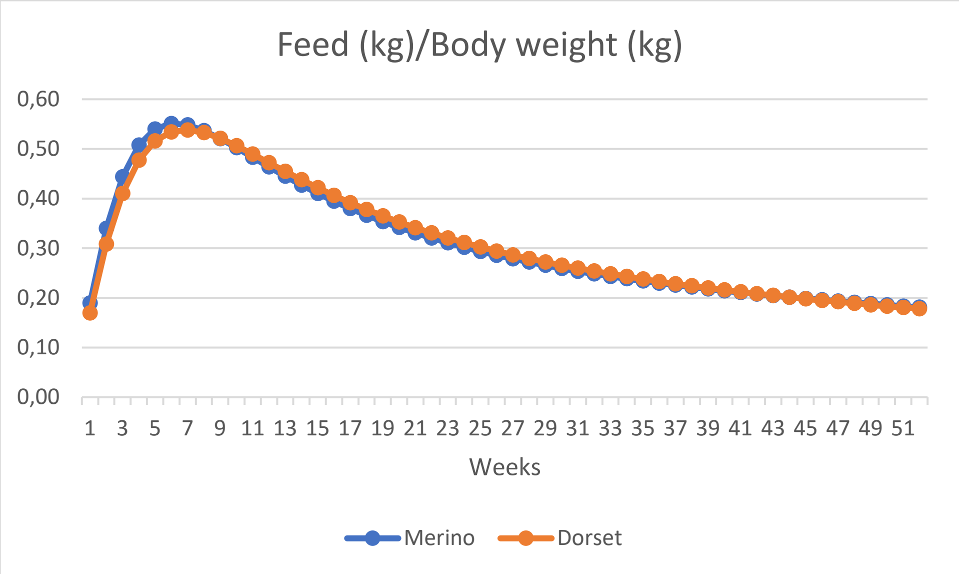

Figure 17. Feed intake in kilogram per body weight in kilogram.

Data for Table 34 and Figure 17 are from J.M. Thompson and J.R. Parks, Anim. Prod. Vol. 36, p. 471-479, 1983.

In FS19, chicken do not take water or straw, only feed. Mature chickens eat about 0.11 kg/day (see Table 35 and Table 36).

Table 35. Weight chart for chicken (layers).

AGE (WEEK)	AVERAGE BODY WEIGHT	AVERAGE FEED INTAKE	CUMULATIVE FEED INTAKE	AVERAGE WATER INTAKE
	(kg/bird)	(g/bird/day)	(kg to date)	(ml/bird/day)
1	0.065	14.5	0.1015	25.5
2	0.125	19	0.2345	38
3	0.19	24	0.4025	46.5
4	0.265	28	0.5985	56.5
5	0.36	35	0.8435	65.5
6	0.46	39	1.1165	71.5
7	0.56	42	1.4105	78
8	0.67	47	1.7395	87
9	0.78	56	2.1315	93
10	0.89	54	2.5095	101
11	0.99	60	2.9295	109.5
12	1.08	64	3.3775	117.5
13	1.165	69	3.8605	124.5
14	1.23	72	4.3645	128.5
15	1.3	74	4.8825	133
16	1.37	77	5.4215	138.5
17 egg laying	1.44	80	5.9815	146.5
18	1.52	85	6.5765	152.5
19	1.62	88	7.1925	161
20	1.68	94	7.8505	169.5
21	1.72	98	8.5365	176.5
22	1.77	102	9.2505	183.5
23	1.8	106	9.9925	188.5
24	1.84	108	10.7485	191
25	1.85	109	11.5115	192.5
26	1.86	110	12.2815	193.5
27	1.88	110	13.0515	193.5
28	1.89	110	13.8215	193.5
29	1.9	110	14.5915	193.5
30	1.9	110	15.3615	193.5
31	1.9	111	16.1385	195
32	1.91	111	16.9155	195
33	1.91	111	17.6925	195
34	1.91	111	18.4695	195
35	1.91	111	19.2465	195
36	1.92	111	20.0235	195

37	1.92	111	20.8005	195
38	1.92	111	21.5775	195
39	1.93	111	22.3545	195
40	1.93	111	23.1315	195
41	1.93	111	23.9085	195
42	1.94	111	24.6855	195
43	1.94	111	25.4625	195
44	1.94	110.5	26.236	195
45	1.95	110	27.006	193.5
46	1.95	110	27.776	193.5
47	1.95	110	28.546	193.5
48	1.95	110	29.316	193.5
49	1.95	110	30.086	193.5
50	1.95	109.5	30.8525	193.5
51	1.95	109	31.6155	191.5
52	1.95	109	32.3785	191.5
53	1.95	109	33.1415	191.5
54	1.95	109	33.9045	191.5
55	1.96	109	34.6675	191.5
56	1.96	109	35.4305	191.5
57	1.96	109	36.1935	191.5
58	1.96	109	36.9565	191.5
59	1.96	109	37.7195	191.5
60	1.96	109	38.4825	191.5
61	1.96	109	39.2455	191.5
62	1.96	109	40.0085	191.5
63	1.96	109	40.7715	191.5
64	1.96	109	41.5345	191.5
65	1.96	109	42.2975	191.5
66	1.96	109	43.0605	191.5
67	1.96	109	43.8235	191.5
68	1.96	109	44.5865	191.5
69	1.96	109	45.3495	191.5
70	1.97	109	46.1125	191.5
71	1.97	109	46.8755	191.5
72	1.97	109	47.6385	191.5
73	1.97	109	48.4015	191.5
74	1.97	109	49.1645	191.5
75	1.97	109	49.9275	191.5
76	1.97	109	50.6905	191.5
77	1.97	109	51.4535	191.5

Table 36. Broiler weight chart.

AGE (DAYS)	FEED CONSUMED PER BIRD (KG)	CUMULATIVE FEED CONSUMED PER BIRD (KG)	AVERAGE BODY WEIGHT (KG)	AVERAGE BODY WEIGHT GAIN PER BIRD (KG)
0	0	0	0.042	0
1	0.013	0.013	0.056	0.014
2	0.016	0.029	0.07	0.014
3	0.02	0.049	0.087	0.017
4	0.023	0.072	0.106	0.019
5	0.026	0.098	0.128	0.022
6	0.03	0.128	0.152	0.024
7	0.035	0.163	0.179	0.027
8	0.038	0.201	0.208	0.029
9	0.042	0.243	0.241	0.033
10	0.047	0.29	0.276	0.035
11	0.052	0.342	0.315	0.039
12	0.057	0.399	0.357	0.042
13	0.062	0.461	0.402	0.045
14	0.067	0.528	0.45	0.048
15	0.073	0.601	0.501	0.051
16	0.078	0.679	0.555	0.054
17	0.084	0.763	0.612	0.057
18	0.09	0.853	0.672	0.06
19	0.096	0.949	0.734	0.062
20	0.102	1.051	0.8	0.066
21	0.108	1.159	0.868	0.068
22	0.114	1.273	0.938	0.07
23	0.12	1.393	1.011	0.073
24	0.126	1.519	1.086	0.075
25	0.132	1.651	1.164	0.078
26	0.137	1.788	1.243	0.079
27	0.144	1.932	1.323	0.08
28	0.148	2.08	1.406	0.083
29	0.155	2.235	1.49	0.084
30	0.159	2.394	1.575	0.085

31	0.165	2.559	1.661	0.086
32	0.17	2.729	1.748	0.087
33	0.175	2.904	1.836	0.088
34	0.179	3.083	1.924	0.088
35	0.183	3.266	2.013	0.089
36	0.188	3.454	2.102	0.089
37	0.191	3.645	2.192	0.09
38	0.196	3.841	2.281	0.089
39	0.198	4.039	2.37	0.089
40	0.203	4.242	2.459	0.089
41	0.205	4.447	2.548	0.089
42	0.208	4.655	2.637	0.089

11.2 Animal intake and output

The following tables enable the user to modify some parameters set in the Seasons mod.

11.2.1 Pig intake and output (typical for Germany).

```
RNS.pigs.color                = {     "RED",         "WHITE",           "BLACK_WHITE",       "BLACK"    };
RNS.pigs.type                 = { "Yorkshire","Gloucestershire Old Spot","Spotted",       "Berkshire"  };
RNS.pigs.fillType             = {     73,             74,                  75,               76       };
RNS.pigs.strawPerDay          = {    0.25,           0.25,                0.25,             0.25      };
RNS.pigs.waterPerDayPerKg     = {    0.03,           0.03,                0.03,             0.03      };
RNS.pigs.foodPerDayPerKg      = {    0.03,           0.03,                0.03,             0.03      };
RNS.pigs.foodTroughFraction   = {      1,              1,                   1,                1       };
RNS.pigs.buyWeight            = {   190.0,            24,                 145,              26.0      };
RNS.pigs.bornWeight           = {   1.575,          1.125,                1.35,            1.575      };
RNS.pigs.milkPerDay           = {    0.00,           0.00,                0.00,             0.00      };
RNS.pigs.manurePerDayPerKg    = {   0.065,          0.065,               0.065,            0.065      };
RNS.pigs.liquidManure         = {   0.039,          0.039,               0.039,            0.039      };
RNS.pigs.foodSpillage         = {    0.00,           0.00,                0.00,             0.00      };
RNS.pigs.fertileAge           = {     0.4,             0,                  0.4,               0       };
RNS.pigs.averageLitterSize    = {      14,             0,                   14,               0       };
RNS.pigs.variationLitterSize  = {       2,             0,                    2,               0       };
RNS.pigs.birthRate            = {       8,             0,                    8,               0       };
RNS.pigs.femalePercentage     = {     0.9,             0,                  0.9,               0       };
RNS.pigs.dailyUpkeep          = {       0,             0,                    0,               0       };
RNS.pigs.buyPriceMultiplier   = {     1.2,           1.2,                  1.2,             1.2       };
RNS.pigs.baseSellPrice        = {       0,             0,                    0,               0       };
RNS.pigs.pricePerKg           = {    1.33,           1.33,                1.33,             1.33      };
RNS.pigs.priceDropAge         = {     180,           180,                  180,              180      };
RNS.pigs.transportPrice       = {      10,            10,                   10,               10      };
RNS.pigs.buyAge               = {     365,            56,                  365,               56      };
RNS.pigs.buyIsFemale          = {    true,          false,                true,            false      };
```

11.2.2 Cow intake and output (typical for Germany).

```
RNS.cowsl.color            = {  "BROWN",      "BROWN_WHITE",   "BLACK",    "BLACK_WHITE"   };
RNS.cowsl.type             = { "Limousin",    "Ayrshire",      "Saler",     "Holstein"     };
RNS.cowsl.fillType         = {    61,            62,             63,           64          };
RNS.cowsl.strawPerDay      = {   1.4,           1.4,            1.4,          1.4          };
RNS.cowsl.waterPerDayPerKg = {   0.09,          0.17,           0.09,         0.17         };
RNS.cowsl.foodPerDayPerKg  = {  0.069,         0.069,          0.069,        0.069         };
RNS.cowsl.foodTroughFraction = { 0.05,          0.1,            0.05,         0.1          };
RNS.cowsl.buyWeight        = {   280,           410,            275,          490          };
RNS.cowsl.bornWeight       = {  40.05,         32.40,          38.00,        40.50         };
RNS.cowsl.milkPerDay       = {   0.00,         25.00,           0.00,        29.00         };
RNS.cowsl.manurePerDayPerKg = { 0.082,         0.082,          0.082,        0.082         };
RNS.cowsl.liquidManure     = {  0.080,         0.130,          0.080,        0.130         };
RNS.cowsl.foodSpillage     = {   0.00,          0.00,           0.00,         0.00         };
RNS.cowsl.fertileAge       = {    0,             2,              0,           0.25         };
RNS.cowsl.averageLitterSize = {   0,             1,              0,            1           };
RNS.cowsl.variationLitterSize= {  0,             0,              0,            0           };
RNS.cowsl.birthRate        = {    0,             4,              0,            4           };
RNS.cowsl.femalePercentage = {    0,            0.9,             0,           0.9          };
RNS.cowsl.dailyUpkeep      = {    0,             0,              0,            0           };
RNS.cowsl.buyPriceMultiplier = {  1.2,           1.2,            1.2,          1.2          };
RNS.cowsl.baseSellPrice    = {    0,             0,              0,            0           };
RNS.cowsl.pricePerKg       = {   1.64,          1.64,           1.64,         1.64         };
RNS.cowsl.priceDropAge     = {   1100,          1100,           1100,         1100         };
RNS.cowsl.transportPrice   = {    20,            20,             20,           20          };
RNS.cowsl.buyAge           = {   230,           700,            300,          700          };
RNS.cowsl.buyIsFemale      = {  false,          true,          false,         true         };
```

11.2.3 Sheep intake and output (typical for Germany).

```
RNS.sheep.color              = {  "WHITE",     "BROWN",    "BLACK_WHITE",    "BLACK"   };
RNS.sheep.type               = { "Dorset",    "Merino",     "Suffolk",      "Dorper"   };
RNS.sheep.fillType           = {    69,          70,           71,            72       };
RNS.sheep.strawPerDay        = {   0.0,         0.0,          0.0,           0.0       };
RNS.sheep.waterPerDayPerKg   = {   0.04,        0.04,         0.04,          0.04      };
RNS.sheep.foodPerDayPerKg    = {  0.085,       0.085,        0.085,         0.085      };
RNS.sheep.foodTroughFraction = {   0.1,         0.1,          0.1,           0.1       };
RNS.sheep.buyWeight          = {   65.0,         50,           70,            60       };
RNS.sheep.bornWeight         = {   4.77,        5.45,        6.255,         5.445      };
RNS.sheep.milkPerDay         = {   0.00,        0.00,         0.00,          0.00      };
RNS.sheep.manurePerDayPerKg  = {   0.00,        0.00,         0.00,          0.00      };
RNS.sheep.liquidManure       = {   0.00,        0.00,         0.00,          0.00      };
RNS.sheep.foodSpillage       = {   0.00,        0.00,         0.00,          0.00      };
RNS.sheep.woolKgPerYear      = {   3.20,        3.20,         3.20,           0        };
RNS.sheep.fertileAge         = {   0.6,         0.6,          0.6,           0.6       };
RNS.sheep.averageLitterSize  = {   1.55,        1.23,         1.65,          1.8       };
RNS.sheep.variationLitterSize = {    1,           1,            1,             1        };
RNS.sheep.birthRate          = {    6,           6,            6,             6        };
RNS.sheep.femalePercentage   = {   0.5,         0.5,          0.5,           0.5       };
RNS.sheep.dailyUpkeep        = {    0,           0,            0,             0        };
RNS.sheep.buyPriceMultiplier = {   1.2,         1.2,          1.2,           1.2       };
RNS.sheep.baseSellPrice      = {    0,           0,            0,             0        };
RNS.sheep.pricePerKg         = {   4.50,        4.50,         4.50,          4.50      };
RNS.sheep.priceDropAge       = {   100,         100,          100,           100       };
RNS.sheep.transportPrice     = {    10,          10,           10,            10       };
RNS.sheep.buyAge             = {   540,         365,          365,           365       };
RNS.sheep.buyIsFemale        = {  true,        true,         true,          true       };
```

A sheep's wool production is set to 3.2 kg/year. With a bale density of 0.375 kg/L this amounts to 8.5 liters of a 1000 liter wool pallet. Hence it requires 117 sheep to produce one wool pallet per year; much less than in the standard game[3].

11.2.4 Chicken intake and output (typical for Germany).

```
RNS.chicken.color             = {  "BLACK",         "WHITE",          "BROWN",            "ROOSTER"    };
RNS.chicken.type              = { "Cornish Cross", "White Leghorn", "Rhode Island Red",  "Rooster"    };
RNS.chicken.fillType          = {    77,              78,               79,                 80        };
RNS.chicken.strawPerDay       = {   0.0,             0.0,              0.0,                0.0        };
RNS.chicken.waterPerDayPerKg  = {   0.1,             0.1,              0.1,                0.1        };
RNS.chicken.foodPerDayPerKg   = { 0.0545,          0.0545,           0.0545,             0.0545       };
RNS.chicken.buyWeight         = {   0.18,           2.138,            2.655,              6.0         };
RNS.chicken.bornWeight        = {  0.036,           0.020,            0.020,               0          };
RNS.chicken.milkPerDay        = {   0.00,            0.00,             0.00,              0.00        };
RNS.chicken.manurePerDayPerKg= {  0.030,           0.030,            0.030,             0.030        };
RNS.chicken.liquidManure      = {   0.00,            0.00,             0.00,              0.00        };
RNS.chicken.foodSpillage      = {   0.00,            0.00,             0.00,              0.00        };
RNS.chicken.eggsPerYear       = {     0,             275,              275,                0          };
RNS.chicken.fertileAge        = {     0,             0.4,              0.4,                0          };
RNS.chicken.averageLitterSize= {      0,               1,                1,                0          };
RNS.chicken.variationLitterSize= {    0,               0,                0,                0          };
RNS.chicken.birthRate         = {     0,              10,               10,                6          };
RNS.chicken.femalePercentage  = {     0,             0.5,              0.5,                0          };
RNS.chicken.dailyUpkeep       = {     0,               0,                0,                0          };
RNS.chicken.buyPriceMultiplier  = { 1.2,             1.2,              1.2,              1.2          };
RNS.chicken.baseSellPrice     = {     0,               0,                0,                0          };
RNS.chicken.pricePerKg        = {   0.90,            0.90,             0.90,              0.90        };
RNS.chicken.priceDropAge      = {    30,              30,               30,                30         };
RNS.chicken.transportPrice    = {     0,               0,                0,                0          };
RNS.chicken.buyAge            = {     7,             140,              140,               200         };
RNS.chicken.buyIsFemale       = {  false,           true,             true,              false        };
```

Chickens are set to lay 275 eggs per year.

11.2.5 Horse intake and output (typical for Germany).

```
RNS.horses1.color             = {"HORSE_TYPE_GREY","HORSE_TYPE_BROWN_WHITE","HORSE_TYPE_BEIGE","HORSE_TYPE_RE
RNS.horses1.type              = {  "Andalusian",      "Paint",           "Haflinger",     "Quarter Horse"   };
RNS.horses1.fillType          = {     58,              56,                53,                 60           };
RNS.horses1.strawPerDay       = {      5,               5,                 5,                  5           };
RNS.horses1.waterPerDayPerKg  = {  0.084,           0.084,             0.084,              0.084          };
RNS.horses1.foodPerDayPerKg   = {  0.025,           0.025,             0.025,              0.025          };
RNS.horses1.buyWeight         = {    545,             470,               430,                455          };
RNS.horses1.bornWeight        = {      0,               0,                 0,                  0          };
RNS.horses1.milkPerDay        = {   0.00,            0.00,              0.00,               0.00          };
RNS.horses1.manurePerDayPerKg= {   0.04,            0.04,              0.04,               0.04          };
RNS.horses1.liquidManure      = {  0.021,           0.021,             0.021,              0.021          };
RNS.horses1.foodSpillage      = {   0.00,            0.00,              0.00,               0.00          };
RNS.horses1.dailyUpkeep       = {      0,               0,                 0,                  0          };
RNS.horses1.buyPriceMultiplier = {     0,               0,                 0,                  0          };
RNS.horses1.baseSellPrice     = {      0,               0,                 0,                  0          };
RNS.horses1.pricePerKg        = {      0,               0,                 0,                  0          };
RNS.horses1.priceDropAge      = {      0,               0,                 0,                  0          };
RNS.horses1.transportPrice    = {     50,              50,                50,                 50          };
RNS.horses1.buyAge            = {   1000,            1000,              1000,               1000          };
RNS.horses1.buyIsFemale       = {  false,           false,             false,              false          };
RNS.horses1.cleanDuration     = {   5000,            5000,              5000,               5000          };
RNS.horses1.liveryIncome      = {   5600,            4300,              5000,               4600          };
RNS.horses1.trainingDifficulty= {    1.5,             1.1,               1.3,                1.2          };
```

[3] SHEEP 201, A beginner's Guide to Raising Sheep. http://www.sheep101.info/201/

With the Seasons mod, horses are not traded and do not produce output.

11.3 Annual feed, bale and land requirements.

When starting up a new map, it is very useful to know how much land is required for a given herd size of animals. One would like to know how much of needed crop types are required as well and how many hectares are needed with the required crop types. This will also enable the player to choose a field of a proper size for a given crop. The script **RealNumbersAnnualFeedPrediction.lua** provides this information based on typical input values controlled by the player.

Using the Seasons mod, feed intake is a function of body weight. So, for a precise calculation of annual feed intake, one would have to reproduce the exact growth curve generated in the Seasons mod. Since the information is scares about the growth curve parameters in the Seasons mod, this is not a viable approach. Instead, the present mod assumes a linear growth rate from a birthing weight to a slaughter weight. The model is illustrated in Figure 18.

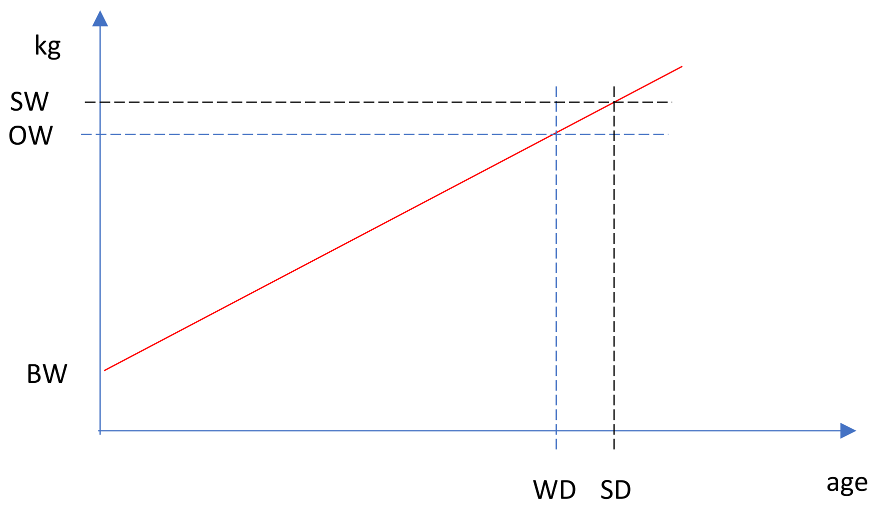

Figure 18. Linear growth model for predicting annual feed requirements.

If we know the birth weight (BW) and an observed weight (OW) at a known weighing day (WD), we can calculate the slope of the linearized growth curve:

$$slope = \frac{OW - BW}{WD}$$

Now we can calculate an estimated live weight (SW) on slaughter day (SD):

$$SW = slope \times SD + BW$$

Knowing the slaughter weight, we can calculate the average weight of the animal from the time of birth till slaughter day:

$$Mean\ weight = \frac{BW + SW}{2}$$

Knowing the amount of feed intake per day per kg body weight, we can now estimate the feed intake for one animal:

$$Feed\ intake = Mean\ weight \times slaghter\ day \times feed\ intake\ per\ day\ per\ kg\ body\ weight.$$

For mature, birth giving animals, we simply use their mature weight. The mod calculates the feed intake for mature animals, female offspring and male offspring and add it all up. For grazing animals, a large fraction of feed comes from grazing. Hence trough feed is set as a small percentage of total feed (5 or 10%). Trough feed intake is then split up into straw, hay and silage according to set percentages (default 25%, 50%, 25%). An example is shown in Figure 19.

```
RNS.cows1.color              = {  "BROWN",      "BROWN_WHITE",     "BLACK",      "BLACK_WHITE"   };
RNS.cows1.type               = { "Limousin",     "Ayrshire",       "Saler",       "Holstein"     };
RNS.cows1.matureWeight       = {   1000,           540,             1000,            680         };
RNS.cows1.weightDay          = {    365,           365,              365,            365         };
RNS.cows1.weightM            = {    566,           480,              516,            495         };
RNS.cows1.weightF            = {    420,           300,              396,            309         };
RNS.cows1.linGrowthPct       = {     85,            85,               85,             85         };
RNS.cows1.monthsToLevelOut   = {     24,            24,               24,             24         };
RNS.cows1.slaughterAge       = {    365,           365,              365,            365         };
RNS.cows1.numberMature       = {     80,            80,               80,             80         };
RNS.cows1.strawPercentage    = {     25,            25,               25,             25         };
RNS.cows1.hayPercentage      = {     50,            50,               50,             50         };
RNS.cows1.silagePercentage   = {     25,            25,               25,             25         };
RNS.cows1.roundBaleVolume    = {   1500,          1500,             1500,           1500         };
RNS.cows1.squareBaleVolume   = {   2600,          2600,             2600,           2600         };
```

Figure 19. Input parameters for estimating feed intake for cows. Weight is in kg and age in days.

Table 37. Estimated need of feed, bales and hectares for 80 Holstein cows.

Holstein			
Number of mature animals	=	80	
Number of offsprings, males	=	8	
Number of offsprings, females	=	72	
Average weight males	=	268	kg
Average weight females	=	175	kg
Average weight gain, males	=	1.2452	kg/day
Average weight gain, females	=	0.7356	kg/day
Slaughter age	=	365	days
Slaughter weight, male	=	495	kg
Slaughter weight, female	=	309	kg
Water per year	=	4289144	L/year
Herd feed intake	=	1740888	kg/year
Herd trough feed	=	174089	kg/year
TMR density	=	0.2200	kg/L
Herd TMR volume	=	791313	L/year
Herd trough silage	=	197828	L/year
Herd trough hay	=	395656	L/year
Herd trough straw	=	197828	L/year
Herd bedding straw	=	628923	L/year

Herd total straw	=	826751	L/year
Round straw bales	=	551	Bales/year
Square straw bales	=	318	Bales/year
Round hay bales	=	264	Bales/year
Square hay bales	=	152	Bales/year
Round silage bales	=	132	Bales/year
Square silage bales	=	76	Bales/year
Straw hectares	=	18.6248	Ha
Hay hectares	=	8.5276	Ha
Silage hectares	=	3.7740	Ha

To obtain a prediction for a different herd size, simply change the number of mature animals from 280 to your desired number in **RealNumbersAnnualFeedPrediction.lua.**

Table 38. Estimated need of feed, bales, and hectares for 24 mature pigs.

Yorkshire			
Number of mature animals	=	24	
Number of offsprings	=	672	per year
Average weight	=	62	kg
Average weight gain	=	1.0035	kg/day
Slaughter age	=	120	days
Slaughter weight	=	122	kg
Water per year	=	293029	L/year
Herd feed intake	=	293029	kg/year
Herd trough feed	=	293029	kg/year
Feedmix density	=	0.7465	kg/L
Herd Feedmix volume	=	392537	L/year
Herd trough cereal	=	98134	L/year
Herd trough maize	=	196268	L/year
Herd trough soybean	=	98134	L/year
Herd bedding straw	=	551734	L/year
Round straw bales	=	368	Bales/year
Square straw bales	=	212	Bales/year
Wheat hectares	=	9.9776	Ha
Maize hectares	=	14.6006	Ha
Soybean hectares	=	26.3695	Ha
Straw hectares	=	12.4293	Ha

Table 39. Estimeted need of feed, bales and hectares for 100 sheep.

Dorset			
Number of mature animals	=	100	
Number of offsprings	=	155	
Average weight	=	24	kg
Average weight gain	=	0.1635	kg/day
Slaughter age	=	240	days
Slaughter weight	=	44	kg
Water per year	=	131185	L/year
Herd feed intake	=	278768	kg/year
Herd trough feed	=	27877	kg/year
TMR density	=	0.2850	kg/L
Herd TMR volume	=	97813	L/year
Herd trough grass	=	48907	L/year
Herd trough hay	=	48907	L/year
Round grass bales	=	33	Bales/year
Square grass bales	=	19	Bales/year
Round hay bales	=	33	Bales/year
Square hay bales	=	19	Bales/year
Hay hectares	=	1.0541	Ha
Grass hectares	=	0.9330	Ha

12 Field information

Different countries do different types of farming. In Table 40 it is seen that 98.5% of all farmland is arable land in Finland, whereas 79% of all farmland is grassland in Ireland.

Table 40. Farmland type distribution in percentage in EU.

	Arable land	Permanent grassland and meadow	Permanent crops	Other
EU-28	59.8	34.2	5.9	0.2
Finland	**98.5**	1.4	0.2	0.0
Denmark	91.5	7.5	1.0	0.0
Sweden	85.1	14.8	0.2	0.0
Hungary	81.6	15.1	3.0	0.3
Lithuania	79.6	19.6	0.8	0.0
Malta	78.8	0.0	11.6	9.7
Poland	74.7	22.3	2.9	0.2
Cyprus	73.3	1.7	**25.0**	0.0
Slovakia	71.7	27.3	1.0	0.0
Czech Republic	71.4	27.5	1.1	0.0
Germany	71.1	27.7	1.2	0.0
Bulgaria	70.5	27.3	2.0	0.1
France	66.6	29.7	3.7	0.0
Estonia	65.6	33.9	0.4	0.1
Latvia	64.1	34.8	0.4	0.7
Romania	62.8	33.7	2.3	1.2
Belgium	61.1	37.2	1.7	0.0
Netherlands	56.2	41.8	2.0	0.0
Croatia	55.9	39.3	4.6	0.1
Italy	55.6	27.4	16.8	0.2
Austria	50.0	47.5	2.4	0.1
Spain	48.5	34.2	17.3	0.0
Luxembourg	47.8	51.1	1.2	0.0
Greece	37.4	43.3	19.1	0.2
United Kingdom	36.7	63.1	0.2	0.0
Slovenia	35.6	58.6	5.6	0.2
Portugal	30.2	49.9	19.5	0.4
Ireland	21.0	**79.0**	0.0	0.0

The average farmland area of farms in EU is shown in Figure 20.

Having obtained information about how much field area is required for a certain number of animals, the script **RealNumbersFieldInfo** provides information about farmlands and fields, their size and price, their crop, their ownership status and if the field can be bought or rented (Table 41).

The purchase or rent price is determined by the hectares of farmland, not the hectares of the field. When a fruit type is undefined, no crop is growing on the field at this moment. The column showing ownership status has four possibilities: for sale, for rent, owned or rented. Pressing **lAlt-rd** will display how many days are left in the field rent year.

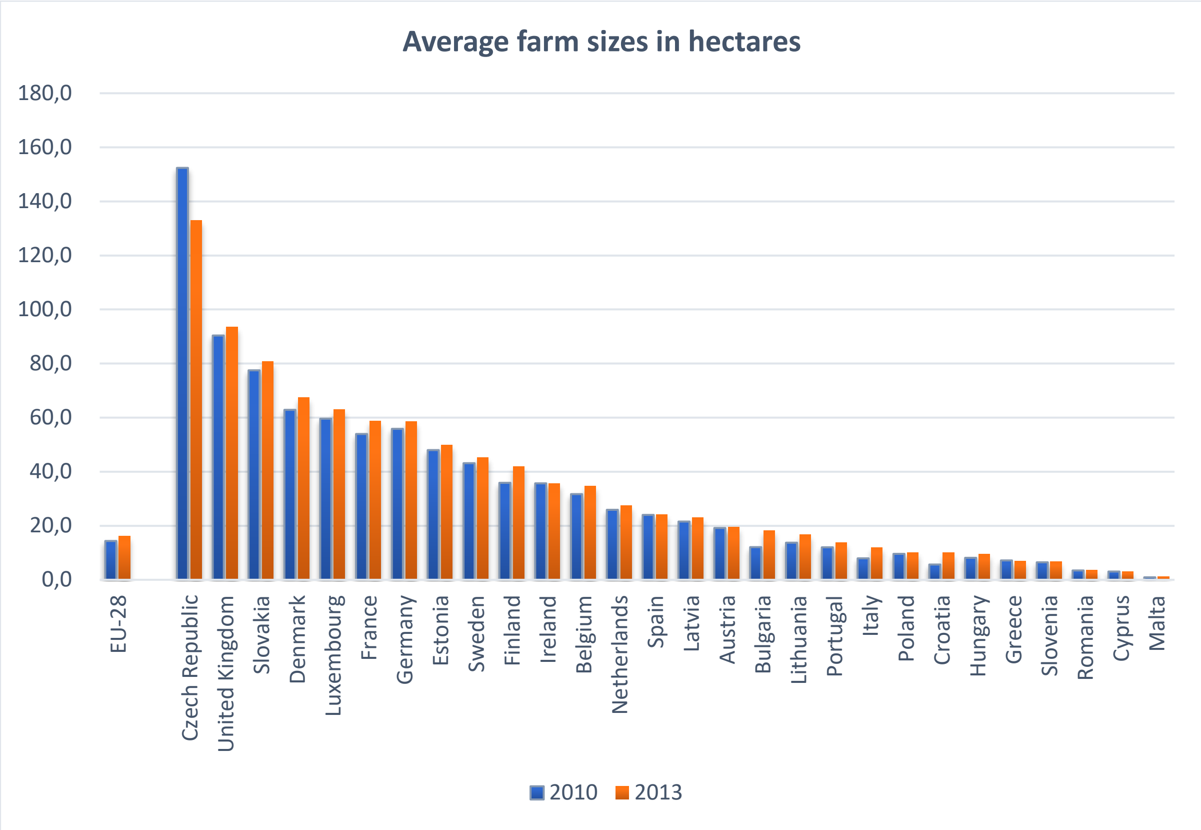

Figure 20. Average land area on farms in EU.

Table 41. Field information for a map. You pay for land area, not field area. Press lAlt-rf.

```
Mean land purchase price = 25000 €/ha
Mean land rent price = 625 €/ha
Field  1: Landarea =  6.3 ha, Fieldarea =  2.3 ha, Price =  157859 €,  For sale, Fruittype: Soybean
Field  2: Landarea =  4.8 ha, Fieldarea =  2.2 ha, Price =  116876 €,  For sale, Fruittype: Barley
Field  3: Landarea =  5.1 ha, Fieldarea =  1.6 ha, Price =  126710 €,  For sale, Fruittype: Grass
Field  4: Landarea =  7.9 ha, Fieldarea =  1.6 ha, Price =  188180 €,  For sale, Fruittype: Barley
Field  5: Landarea =  4.6 ha, Fieldarea =  1.0 ha, Price =    2931 €,  For rent, Fruittype: Undefined
Field  6: Landarea = 14.2 ha, Fieldarea =  5.2 ha, Price =  364945 €,  Owned   , Fruittype: Wheat
Field  7: Landarea =  8.4 ha, Fieldarea =  3.8 ha, Price =  216774 €,  Owned   , Fruittype: Barley
Field  8: Landarea =  5.5 ha, Fieldarea =  2.6 ha, Price =  136271 €,  For sale, Fruittype: Sugarbeet
Field  9: Landarea =  4.9 ha, Fieldarea =  3.0 ha, Price =    2998 €,  Rented  , Fruittype: Barley
Field 10: Landarea =  8.8 ha, Fieldarea =  5.2 ha, Price =  226029 €,  Owned   , Fruittype: Sunflower
Field 11: Landarea =  3.2 ha, Fieldarea =  2.1 ha, Price =   81448 €,  Owned   , Fruittype: Wheat
Field 12: Landarea =  7.6 ha, Fieldarea =  5.6 ha, Price =  197587 €,  For sale, Fruittype: Undefined
Field 13: Landarea =  5.1 ha, Fieldarea =  4.1 ha, Price =  132828 €,  For sale, Fruittype: Undefined
Field 14: Landarea =  6.7 ha, Fieldarea =  3.9 ha, Price =    4268 €,  Rented  , Fruittype: Oat
Field 15: Landarea =  3.8 ha, Fieldarea =  1.3 ha, Price =   96010 €,  For sale, Fruittype: Wheat
Field 16: Landarea = 10.1 ha, Fieldarea =  4.8 ha, Price =    6202 €,  For rent, Fruittype: Barley
Field 17: Landarea =  4.4 ha, Fieldarea =  3.0 ha, Price =  106361 €,  Owned   , Fruittype: Wheat
Field 18: Landarea =  3.0 ha, Fieldarea =  2.0 ha, Price =   73283 €,  For sale, Fruittype: Undefined
Field 19: Landarea =  2.9 ha, Fieldarea =  1.6 ha, Price =   72262 €,  For sale, Fruittype: Undefined
Field 20: Landarea =  3.0 ha, Fieldarea =  0.7 ha, Price =    1887 €,  For rent, Fruittype: Undefined
Field 21: Landarea =  4.7 ha, Fieldarea =  2.4 ha, Price =  111652 €,  Owned   , Fruittype: Grass
Field 22: Landarea =  6.7 ha, Fieldarea =  3.8 ha, Price =  161355 €,  Owned   , Fruittype: Grass
Field 23: Landarea =  7.4 ha, Fieldarea =  2.2 ha, Price =    4439 €,  For rent, Fruittype: Undefined
Field 24: Landarea =  4.9 ha, Fieldarea =  1.3 ha, Price =  121884 €,  For sale, Fruittype: Undefined
Field 25: Landarea =  2.6 ha, Fieldarea =  0.7 ha, Price =   62971 €,  For sale, Fruittype: Canola
Field 26: Landarea =  2.1 ha, Fieldarea =  1.2 ha, Price =   52968 €,  Owned   , Fruittype: Grass
Field 27: Landarea =  3.4 ha, Fieldarea =  1.7 ha, Price =   86656 €,  Owned   , Fruittype: Barley
Field 28: Landarea =  1.8 ha, Fieldarea =  0.6 ha, Price =    1070 €,  Rented  , Fruittype: Potato
Field 29: Landarea =  2.1 ha, Fieldarea =  0.5 ha, Price =   53019 €,  For sale, Fruittype: Undefined
Field 30: Landarea =  3.0 ha, Fieldarea =  1.6 ha, Price =   75270 €,  Owned   , Fruittype: Grass
Field 31: Landarea =  3.7 ha, Fieldarea =  1.6 ha, Price =   93322 €,  For sale, Fruittype: Undefined
Field 32: Landarea =  3.4 ha, Fieldarea =  1.0 ha, Price =    2044 €,  For rent, Fruittype: Undefined
Field 33: Landarea =  4.5 ha, Fieldarea =  1.2 ha, Price =  115395 €,  For sale, Fruittype: Sunflower
```

All field rent contracts are terminated on the same day, defined as the *rent termination day*. By default, this is on the first day of mid-winter. ***On that day, rent prices are set to zero and all attempts to rent fields are cancelled. On the following day, rent contracts can be renewed or new fields can be rented***. Rented fields can be sold with a reimbursement corresponding to the rest of the rent cost for that rent year.

To have an idea about how much field work lies ahead, Table 42 sums up the hectares of different crop groups. This helps deciding the size of headers for your harvester and width of implements such as ploughs, cultivators and seeders. Compare what you own with what you need by also pressing lAlt-ra to see required crop hectares for your herd size.

The present script needs to delay its execution until the map loading has completed. For this reason, this script is **only run when the user presses lAlt-rf**, i.e. the left Alt key is held down while pressing r and f simultaneously.

Table 42. Summary of feed crop area on farm.

```
   Total farmland area owned/rented          =      78.0  Ha
   Total field area owned/rented             =      39.5  Ha
   Grain crop area                           =      14.0  Ha
   Protein crop area                         =       5.2  Ha
   Maize area                                =       2.9  Ha
   Potato area                               =       1.4  Ha
   Sugarbeet area                            =       0.0  Ha
   Grass area                                =       1.7  Ha
```

On some maps, several fields are grouped into one farmland, and all fields in the group must be purchased or rented. An example of this concept is seen on the Eire map (see Table 43).

Table 43. Alternative field listing organized in farmland groups. Press lAlt-rt to get this view.

```
  Farmland   1: Land area =  2.8 ha,  Price =   70432 €, Ownership:  For sale
                Field  41: Field area =  0.3 ha,   Fruit: REDCABBAGE
                Field  42: Field area =  0.6 ha,   Fruit: Undefined
  Farmland   2: Land area =  1.6 ha,  Price =   40058 €, Ownership:  For sale
                Field  40: Field area =  1.6 ha,   Fruit: Undefined
  Farmland   3: Land area =  2.3 ha,  Price =   53939 €, Ownership:  For sale
                Field  39: Field area =  0.9 ha,   Fruit: Undefined
  Farmland   4: Land area =  2.8 ha,  Price =   70172 €, Ownership:  For sale
                Field  24: Field area =  2.0 ha,   Fruit: Undefined
  Farmland   5: Land area =  3.8 ha,  Price =    1507 €, Ownership:  For rent
                Field  23: Field area =  2.0 ha,   Fruit: POTATO
                Field  33: Field area =  1.4 ha,   Fruit: Undefined
  Farmland   6: Land area =  3.5 ha,  Price =   89787 €, Ownership:  Owned
                Field  32: Field area =  1.9 ha,   Fruit: Undefined
                Field  34: Field area =  1.3 ha,   Fruit: CABBAGE
  Farmland   7: Land area =  4.1 ha,  Price =  102113 €, Ownership:  For sale
                Field  21: Field area =  1.9 ha,   Fruit: Undefined
                Field  22: Field area =  1.6 ha,   Fruit: Undefined
  Farmland   8: Land area =  1.9 ha,  Price =   48397 €, Ownership:  For sale
                Field  25: Field area =  0.6 ha,   Fruit: Undefined
                Field  26: Field area =  0.7 ha,   Fruit: SUGARBEET
  Farmland   9: Land area =  4.6 ha,  Price =    1945 €, Ownership:  Rented
                Field  30: Field area =  2.3 ha,   Fruit: LETTUCE
                Field  31: Field area =  1.7 ha,   Fruit: Undefined
  Farmland  10: Land area =  6.0 ha,  Price =  141986 €, Ownership:  For sale
                Field  36: Field area =  3.9 ha,   Fruit: Undefined
                Field  37: Field area =  2.0 ha,   Fruit: Undefined
```

On these maps an alternative listing is required, showing how fields are grouped, and what fields are rentable. In Table 43, farmlands 5 and 9 are rentable. Hence fields 30 and 31 are rented in one group and fields 41 and 42 are rented in another group.

A field will have an undefined fruit type if it has been plowed or cultivated after harvest. Normally, the fruit type will be redefined when the field is reseeded. However, on some multifruit maps, the fruit type remains undefined after being reseeded with a non-standard fruit. The fruit type map will still show the correct fruit type color, but fruit type index is missing from the table defining fields.

Figure 21. Another day on the farm. Fenton Forest by Stevie.

Figure 22. Before an error causing an excessive production of wool was fixed.

13 Contracts

The script **RealNumbersContracts** attempts to turn the mission feature 180 degrees. In the default game, landowners offer odd jobs to the game player and pays out a predetermined award, which the game player then must accept or reject. The script **RealNumbersContracts** enables the game player to set up a Farming Contractor business and design contracts for a range of job types.

This script does not alter the cost of hired helpers. However, there is an excellent mod **HelperAdmin** by apuehri/LS-Modcompany, in which the wage can be changed to real-life wages. **Seasons** also defines helper fees and may potentially interfere with HelperAdmin.

In previous versions of the mod, contract fees were calculated based on hourly rates. This approach has been abandoned because most contractors work with a flat rate per hectare for the majority of contracting services.

Table 44. Contract fees in €/ha. Defined in the script RealNumbersEquipmentEconomy.lua.

```
RN.contractRatePerHour["TRACTOR200HP"]          =  83;
RN.contractRatePerHa.MANURESPREADER             = 130;
RN.contractRatePerHa.SLURRYTANKS                = 130;
RN.contractRatePerHa.PLOWS                      = 112;
RN.contractRatePerHa.DISCHARROWS                =  35;
RN.contractRatePerHa.CULTIVATORS                =  35;
RN.contractRatePerHa.SEEDERS                    =  77;
RN.contractRatePerHa.PLANTERS                   =  42;
RN.contractRatePerHa.FERTILIZERSPREADERS        =  21;
RN.contractRatePerHa.LIMESPREADERS              =  21;
RN.contractRatePerHa.SPRAYERS                   =  28;
RN.contractRatePerHa.WEEDERS                    =  19;
RN.contractRatePerHa.HARVESTERS                 = 165;
RN.contractRatePerHa.FORAGEHARVESTERS           = 165;
RN.contractRatePerHa.POTATOPLANTERS             = 195;
RN.contractRatePerHa.POTATOHARVESTING           = 660;
RN.contractRatePerHa.BEETHARVESTING             = 290;
RN.contractRatePerHa.MOWERS                     =  65;
RN.contractRatePerHa.TEDDERS                    =  22;
RN.contractRatePerHa.WINDROWERS                 =  22;
RN.contractRatePerHa.SNOW                       = 100;
```

In some cases, contracts require the use of a single piece of equipment, such as a plow. In others is involves several pieces of equipment, such as mowing and baling.

For contracts like seeding, fertilizing, and spraying, the contractor delivers the seed, fertilizer and herbicide. As seen in the example contracts in Table 45, the cost of fertilizer and herbicide is frequently much higher than any other items on the contract. Consequently, the contractor should be reimbursed for such expenses. Although there is a “reimbursement” item on the screen when collecting the payment, this field seem always to be zero, even when the reimbursement variable has been assigned an appropriate value. For this reason, the RealLifeNumbers adds the reimbursement to the “reward” variable, such that full payment is secured.

Table 45. Example contracts. In multiplayer mode, this information is not shared with client computers.

cultivate field	=	42	
cultivate field area	=	7.3833	Ha
cultivate fertilizer state	=	67	%
cultivate lime state	=	100	%
cultivate herbicide state	=	100	%
cultivate plow state	=	100	%
cultivate yield factor	=	168	%
cultivate reward per ha	=	35.0000	€/Ha
cultivate total reward	=	258.4155	€
cultivate vehicle use cost	=	94.2149	€
cultivate total reimbursement	=	258.4155	€
fertilize field	=	37	
fertilize crop: BARLEY	=	2	
fertilize field area	=	2.9223	Ha
fertilize fertilizer state	=	67	%
fertilize lime state	=	100	%
fertilize herbicide state	=	100	%
fertilize plow state	=	100	%
fertilize yield factor	=	168	%
fertilize reward per ha	=	21.0000	€/Ha
fertilize total reward	=	61.3693	€
fertilize vehicle use cost	=	7.1284	€
fertilize fertilizer cost	=	210.9477	€
fertilize total reimbursement	=	272.3170	€
fertilize fertilizer liter/ha	=	214.1204	L/Ha
fertilize fertilizer cost/Liter	=	0.5023	€/L
fertilize fertilizer cost/ha	=	107.5607	€/Ha
harvest field	=	5	
harvest crop: BARLEY	=	2	
harvest field area	=	1.8861	Ha
harvest fertilizer state	=	0	%
harvest lime state	=	100	%
harvest herbicide state	=	100	%
harvest plow state	=	100	%
harvest yield factor	=	135	%
harvest reward per ha	=	165.0000	€/Ha
harvest total reward	=	311.2065	€
harvest vehicle use cost	=	32.1973	€
harvest total reimbursement	=	311.2065	€
harvest deliver to Restaurant			
harvest crop price/ha	=	687.4534	€/Ha
harvest max yield/ha	=	5977.3463	L/Ha
harvest max crop price	=	1296.6059	€
harvest max yield	=	11273.8728	L
harvest expected yield	=	7609.8642	L
harvest standard crop price/L	=	0.1150	€/L
harvest expected crop price	=	875.2090	€

For harvest contracts, FS19 pays the contractor a fraction of the sell price for the harvest. This will then be a bonus on top of the contract. Giants' motivation for this policy is unknown.

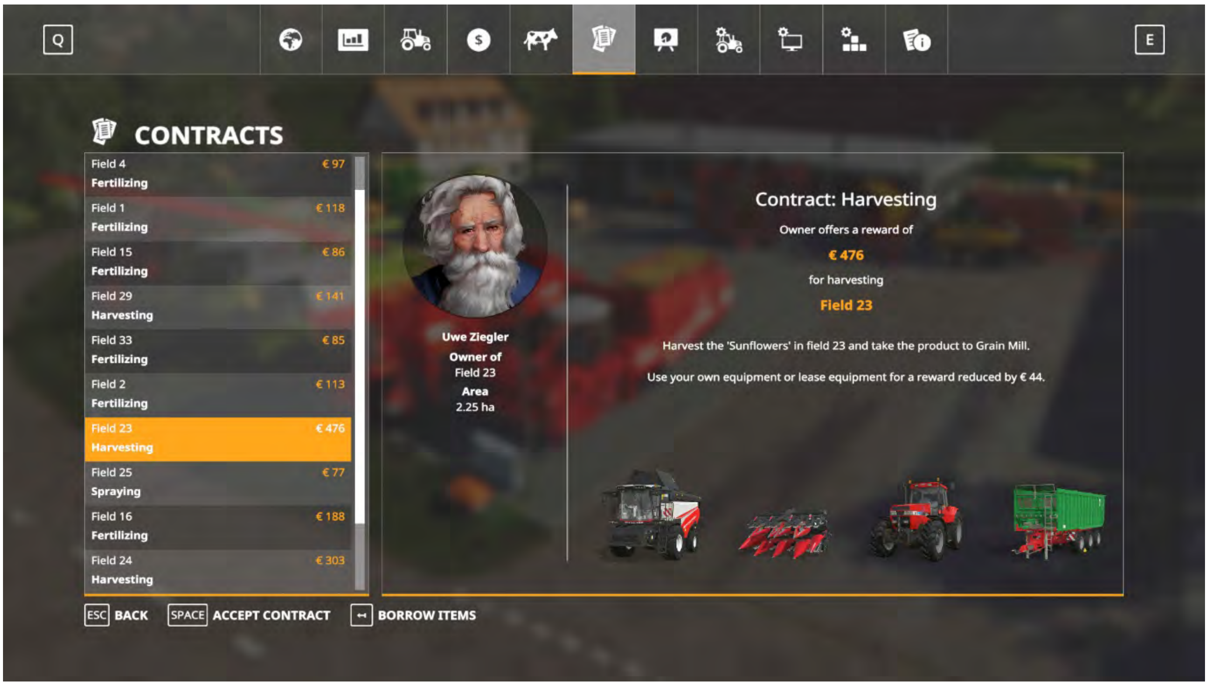

Figure 23. Contracts to be signed.

The contracting feature involves a lot of synchronization between host and clients when playing in multiplayer mode. The itemized contracts (Table 45) is not distributed to client PCs in RealLifeNumbers. Hence, client PCs will not get a list of itemized contracts when pressing lAlt-rc. Clients are still able to see the contracts in the in-game menu and will also be rewarded the amount setup in this mod.

14 Equipment economy

The objective of the new script RealNumbersEquipmentEconomy.lua is exclusively to provide information about how expensive it is to own a given equipment and if the cost of ownership exceeds the cost of hiring a contractor for the same job. The script does not control the gameplay, it only provides economic insight into your farming operation.

14.1 Tractors

Table 46. General parameters for calculating equipment cost. In RealNumbersEquipmentCost.lua

```
RN.loanYears                   = 7;
RN.salaryPerHour               = 16.50;
RN.equipmentTax                = 0.01;
RN.equipmentInsurance          = 0.005;
RN.equipmentHousing            = 0.005;
RN.equipmentRepairFactor       = 0.01;
RN.fuelPerHourPerHP            = 0.1667;
RN.lubricationFractionOfFuel = 0.15;
RN.fuelCostPerLiter            = RN.commodityDensity.FUEL *
                                  RN.commodityPricePer100kg.FUEL/100;
RN.tractorFieldHoursPerYear   = 400;
```

Table 47. Cost parameters for tractor.

```
RN.equipment.price["TRACTOR100HP"]                    = 65000; --  €
RN.equipment.loanTime["TRACTOR100HP"]                 = RN.loanYears;    -- years
RN.equipment.lifeTime["TRACTOR100HP"]                 = 15;  -- years
RN.equipment.depreciationRate["TRACTOR100HP"]         = 0.1; -- 10%
RN.equipment.neededHP["TRACTOR100HP"]                 = 100;  -- hp
RN.equipment.fuelPerHourPerHP["TRACTOR100HP"]         = RN.fuelPerHourPerHP;
RN.equipment.fieldHours["TRACTOR100HP"]               = RN.tractorFieldHoursPerYear;
RN.contractRatePerHour["TRACTOR100HP"] = RN.contractRatePerHour["TRACTOR200HP"]
                                         + (RN.equipment.neededHP["TRACTOR100HP"] - 200)
```

Loan interest is set in RealNumbersInitialization.lua together with inflation rate. The net interest rate on loans is the loan interest (default 4%) minus the inflation rate (default 2%). The loan period is set to 7 years. The calculations following here are adapted from work presented by William Edwards, Extension economist at Iowa State University[4].

$$Interest = Loan \times (1 + Net\ interest\ rate)^{Loan\ duation} - Loan$$

$$Interest = 65000 \times \left(1 + (0.04 - 0.02)\right)^{7} - 65000 = 65000 \times 1.1487 - 65000 = 9665.5\ €$$

[4] William Edwards, Estimating Farm Machinery Cost, A3-29. https://www.extension.iastate.edu/agdm/crops/html/a3-29.html

The lifetime is set to 15 years for tractors. Within the 15 years the tractor depreciates in value by 10% per year. The total cost of depreciation is divided evenly of the 15 years (linear depreciation). The sell price is then the purchase price minus the total depreciation over 15 years.

$$Sell\ price = Purchase\ price \times (1 - Depreciation\ rate)^{Lifetime}$$

$$Sell\ price = 65000 \times (1 - 0.1)^{15} = 65000 \times 0.2059 = 13383.5\ €$$

$$Loan\ payment = Purchase\ price - Sell\ price + Interest$$

$$Loan\ payment = 65000 - 13383.5 + 9665.5 = 61282\ €$$

$$Life\ time\ depreciation = Purchase\ price - Sell\ price$$

$$Lifetime\ depreciation = 65000 - 13383.5 = 51616.5\ €$$

$$Investment\ cost = Loan\ payment + Lifetime\ depreciation$$

$$Investment\ cost = 61282 + 51616.5 = 112898.5\ €$$

$$Investment\ cost\ per\ year = \frac{Investment\ cost}{Lifetime}$$

$$Investment\ cost\ per\ year = \frac{112898.5\ €}{15} = 7526.6\ €$$

Annual cost for tax, insurance and housing are set to 1%, 0.5% and 0.5% respectively, of the average value between purchase and selling.

$$Tax\ per\ year = Tax\ rate \times \frac{Purchase\ price + Sell\ price}{2} \times \frac{1}{Lifetime}$$

$$Tax\ per\ year = 0.01 \times \frac{65000\ € + 13383.5\ €}{2} \times \frac{1}{15} = 26.13\ €$$

$$Insurance\ per\ year = Insurance\ rate \times \frac{Purchase\ price + Sell\ price}{2} \times \frac{1}{Lifetime}$$

$$Insurance\ per\ year = 0.005 \times \frac{65000\ € + 13383.5\ €}{2} \times \frac{1}{15} = 13.065\ €$$

$$Housing\ per\ year = Housing\ rate \times \frac{Purchase\ price + Sell\ price}{2} \times \frac{1}{Lifetime}$$

$$Housing\ per\ year = 0.005 \times \frac{65000\ € + 13383.5\ €}{2} \times \frac{1}{15} = 13.065\ €$$

$$Tax + Insurance + Housing\ per\ year = 26.13 + 13.065 + 13.065 = 52\ €$$

$$Fixed\ cost\ per\ year = Investment\ cost + Tax + Insurance + Housing$$

$$Fixed\ cost\ per\ year = 7526.6\ € + 52\ € = 7578.6\ €$$

$$Fixed\ cost\ per\ hour = \frac{Fixed\ cost\ per\ year}{Hours\ per\ year}$$

$$Fixed\ cost\ per\ hour = \frac{7578.6\ €}{400} = 18.9\ €/hour$$

The variable cost of tractors includes repairs, fuel, lubrication and labor. The total cost of repair over 15 years is set to 1% of the purchase price. Fuels consumption is et to 0.1667 L per hour per hp. For a 100 hp tractor this would be 16.67 L/hour. Multiplying by the cost of fuel per liter we get the fuel cost per hour. The lubrication cost is set at 15% of fuel cost. Labor cost is set to 16.5 € per hour.

Example calculations for 5 tractors are shown in Table 48. Fixed costs include financing, depreciation, tax, insurance, and housing. Variable (operating) costs includes fuel, lubrication, labor, and repairs. For a 100 HP tractor, the operating cost per hour is about 39 € and the fixed cost about 19 €/hour for 400 hours per year. The total cost is then 50 €/hour. Renting a contractor to provide a driver and a 100 HP tractor will cost about 66 €/hour. So, for this size tractor, used for 400 hours per year, it pays off to own the tractor.

For the 200 HP tractor it is cheaper to hire a contractor. You will need to use the purchased tractor for 630 hours per year to reach break-even. For the 500 HP tractor, break-even hours per year is 1024.

Table 48. Cost of tractor ownership.

		TRACTOR100HP	TRACTOR200HP	TRACTOR300HP	TRACTOR400HP	TRACTOR500
Price	€	65000	199000	265000	315000	382000
Loan time	years	7	7	7	7	7
Life time	years	15	15	15	15	15
Net interest rate	%	2.0000	2.0000	2.0000	2.0000	2.0000
Interest cost	€	9665	29588	39402	46836	56798
Loan cost	€	74665	228588	304402	361836	438798
Depreciation rate per year	-	0.1000	0.1000	0.1000	0.1000	0.1000
Salvage fraction	-	0.2059	0.2059	0.2059	0.2059	0.2059
Sell price	€	13383	40972	54561	64856	78650
Loan payment	€	61282	187616	249841	296980	360148
Life time depreciation	€	51617	158028	210439	250144	303350
Investment cost	€	112899	345644	460279	547125	663497
Investment cost per year	€/year	7527	23043	30685	36475	44233
Tax, insurance, housing cost	€/year	52	160	213	253	307
Fixed cost per year	€/year	7579	23203	30898	36728	44540
Tractor hours per year	hours/year	400.0000	400.0000	400.0000	400.0000	400.0000
Tractor hours life time	hours	6000	6000	6000	6000	6000
Repair factor	-	0.0100	0.0100	0.0100	0.0100	0.0100
Repairs per year	€/year	43	133	177	210	255
Repairs per hour	€/hour	0.1083	0.3317	0.4417	0.5250	0.6367
Tractor HP	hp	100	205	300	400	517
Fuel per hour	L/hour	16.6700	34.1735	50.0100	66.6800	86.1839
Fuel cost per hour	€/hour	12.8588	26.3606	38.5765	51.4353	66.4801
Lubrication cost per hour	€/hour	1.9288	3.9541	5.7865	7.7153	9.9720
Labor cost per hour	€/hour	16.5000	16.5000	16.5000	16.5000	16.5000
Operating cost per hour	€/hour	31.3960	47.1463	61.3046	76.1756	93.5888
Ownership cost per hour	€/hour	18.9471	58.0073	77.2458	91.8205	111.3506
Tractor cost per hour	€/hour	50	105	139	168	205
Tractor cost per year	€/year	20137	42061	55420	67198	81976
Contract cost per hour	€/hour	66	84	101	117	137
Contract cost per year	€/year	26532	33533	40201	46869	54671
Break-even field hours	hours/year	218	630	784	890	1024

The user of the mod can of course change the data to fit specific tractors on their farm. For tractors, the primary parameters to adjust are the purchase price and the horsepower. The key parameter to monitor is the break-even hours. If this is higher than your expected use of the tractor measured in hours per year, then the tractor is too expensive for your farming operation.

The break-even hours are measured against typical contracting prices in Denmark. The user will have to adjust the contracting rates to local values, if they differ significantly from the rates used as default. The contract rates for tractors are scaled to horse powers based on a known contract rate for a 200 hp tractor (84 € per hour plus/minus 0.1667 € per hp).

$$Tractor\ hire = Tractor\ rate_{200\ hp} + (HP - 200) \times 0.1667$$

$$Tractor\ hire_{400\ hp} = 84\frac{€}{hour} + (400 - 200) \times 0.1667 = 117\frac{€}{hour}$$

14.2 Implements

The fixed and variable costs of implements are calculated in ways similar to that for tractors, except, costs are per hectare rather than per hours. The variable cost, here called Operating cost, includes cost of fuel. Fuel is here calculated on the estimated horsepower needed to pull the implement, not on the engine horsepower of the tractor. The rational of this is that a 500 hp tractor will use much less fuel pulling a windrower than pulling a 12 m wide cultivator.

Table 49. Input parameters for estimating equipment ownership cost. More equipment included in the script.

```
RN.equipment.price["MANURESPREADER"]                 = 27500; --  €
RN.equipment.loanTime["MANURESPREADER"]              = RN.loanYears;     -- years
RN.equipment.lifeTime["MANURESPREADER"]              = 20;     -- years
RN.equipment.depreciationRate["MANURESPREADER"]      = 0.1;
RN.equipment.width["MANURESPREADER"]                 = 9;   -- m
RN.equipment.speed["MANURESPREADER"]                 = 8;   -- kph
RN.equipment.efficiency["MANURESPREADER"]            = 0.63;
RN.equipment.workArea["MANURESPREADER"]        = RN.fieldArea["MANURESPREADER"];
RN.equipment.neededHP["MANURESPREADER"]              = 110; -- hp
RN.equipment.fuelPerHourPerHP["MANURESPREADER"]      = RN.fuelPerHourPerHP;

RN.equipment.price["DISCHARROWS"]                    = 18000; --  €
RN.equipment.loanTime["DISCHARROWS"]                 = RN.loanYears;     -- years
RN.equipment.lifeTime["DISCHARROWS"]                 = 20;     -- years
RN.equipment.depreciationRate["DISCHARROWS"]         = 0.1;
RN.equipment.width["DISCHARROWS"]                    = 3;   -- m
RN.equipment.speed["DISCHARROWS"]                    = 10;  -- kph
RN.equipment.efficiency["DISCHARROWS"]               = 0.83;
RN.equipment.workArea["DISCHARROWS"]           = RN.fieldArea["DISCHARROWS"];
RN.equipment.neededHP["DISCHARROWS"]                 = 100; -- hp
RN.equipment.fuelPerHourPerHP["DISCHARROWS"]         = RN.fuelPerHourPerHP;

RN.equipment.price["HARVESTERS"]                     = 156000; --  €
RN.equipment.loanTime["HARVESTERS"]                  = RN.loanYears;     -- years
RN.equipment.lifeTime["HARVESTERS"]                  = 15;     -- years
RN.equipment.depreciationRate["HARVESTERS"]          = 0.1;
RN.equipment.width["HARVESTERS"]                     = 5;   -- m
RN.equipment.speed["HARVESTERS"]                     = 7;   -- kph
RN.equipment.efficiency["HARVESTERS"]                = 0.82;
RN.equipment.workArea["HARVESTERS"]            = RN.fieldArea["HARVESTERS"];
RN.equipment.neededHP["HARVESTERS"]                  = 180; -- hp
RN.equipment.fuelPerHourPerHP["HARVESTERS"]          = RN.fuelPerHourPerHP;
```

The script uses a set of input parameters for each implement (Table 49). Key parameters are the purchase price, the implement width, the work speed, and field efficiency. The latter three parameters are used to calculate the field capacity of the implement.

$$Field\ capacity\ \left(\frac{ha}{hour}\right) = \frac{width\ (m) \times speed(kph) \times efficiency}{10}$$

Using the equation on the small harvester in Table 49, we get:

$$Field\ capacity = \frac{5\ m \times 7\ kph \times 0.82}{10} = 2.87\ ha/hour$$

Field efficiency is always less than 100%. Some time is wasted on turns at the head lands, some is used for emptying or refilling implement, and some is wasted because the full width of the equipment is not used due to overlap between runs. Implements with frequent refills, such as a manure spreader, will have a low efficiency even if the width is large. The width used in the script are those found on implements in FS19. The working speed is typical real-life working speed, not the max speed in FS19.

Table 50. Break-even analysis of owning and using implements.

		MANURESPREADER	SLURRYTANKS	PLOWS	DISCHARROWS	CULTIVATORS
Price	€	27500	23000	14000	18000	7000
Loan duration	years	7	7	7	7	7
Life time	years	20	20	20	20	20
Net interest rate	%	2.0000	2.0000	2.0000	2.0000	2.0000
Interest cost	€	4089	3420	2082	2676	1041
Loan cost	€	31589	26420	16082	20676	8041
Depreciation rate per year	-	0.1000	0.1000	0.1000	0.1000	0.1000
Salvage fraction	-	0.1216	0.1216	0.1216	0.1216	0.1216
Sell price	€	3343	2796	1702	2188	851
Loan payment	€	28245	23624	14380	18488	7190
Life time depreciation	€	24157	20204	12298	15812	6149
Investment cost	€	52402	43827	26677	34300	13339
Investment cost per year	€/year	2620	2191	1334	1715	667
Tax, insurance, housing cost	€/year	15	13	8	10	4
Fixed cost per year	€/year	2636	2204	1342	1725	671
Implement width	m	9.0000	9.0000	2.5000	3.0000	3.0000
Implement speed	kph	8.0000	8.0000	12.0000	10.0000	15.0000
Implement efficiency	-	0.6300	0.6000	0.8500	0.8300	0.8500
Implement capacity	ha/hour	4.5360	4.3200	2.5500	2.4900	3.8250
Implement work area	ha/year	75.0000	8.0000	55.0000	125.0000	94.2500
Implement hours per year	hours/year	16.5344	1.8519	21.5686	50.2008	24.6405
Implement hours life time	hours	331	37	431	1004	493
Repair factor	-	0.0100	0.0100	0.0100	0.0100	0.0100
Repairs per year	€/year	14	12	7	9	4
Repairs per hour	€/hour	0.8316	6.2100	0.3245	0.1793	0.1420
Required HP	hp	110	85	150	100	100
Fuel per hour	L/hour	18.3370	14.1695	25.0050	16.6700	16.6700
Fuel cost per hour	€/hour	23.9298	18.4912	32.6315	21.7543	21.7543
Lubrication cost per hour	€/hour	3.5895	2.7737	4.8947	3.2632	3.2632
Labor cost per hour	€/hour	16.5000	16.5000	16.5000	16.5000	16.5000
Operating cost per hour	€/hour	44.8509	43.9749	54.3508	41.6968	41.6595
Operating cost per ha	€/ha	9.8878	10.1794	21.3140	16.7457	10.8914
Fixed cost per ha	€/ha	35.1404	275.5325	24.3950	13.8006	7.1179
Fixed + op. cost per ha	€/ha	45	286	46	31	18
Fixed + op. cost per hour	€/hour	204	1234	117	76	69
Fixed + op. cost per year	€/year	3377	2286	2514	3818	1697
Contract cost per ha	€/ha	130	130	112	35	35
Contract cost per hour	€/hour	590	562	286	87	134
Contract cost per year	€/year	9750	1040	6160	4375	3299
Break-even fixed cost per ha	€/ha	120	120	91	18	24
Break-even ha	ha/year	22	18	15	95	28
Break-even field hours	hours/year	5	4	6	38	7

The operating cost includes fuel, lubrication and labor. To calculate these costs, we need to know the number of hours of use per year of the implement. We therefore need to enter the estimated total work area per year for the equipment. For the manure spreader in Table 50, the total work area is set to 75 ha/year. With a field capacity of 4.54 ha/hour, we get 16.5 hours per year. Using the hourly cost of repair, fuel, lubrication and labor, we can calculate the operating cost per hour and per hectare. Dividing the annual fixed cost with the total work are, we also get the fixed cost per hectare. The sum of fixed cost and operating cost gives us the expense per hectare of owning and using the implement. We can compare this cost to the cost of hiring a contractor.

For the manure spreader the total cost of ownership and use adds up to 45 € per ha. The cost of hiring a contractor is 130 € per ha. The break-even hectare is 22 ha, meaning if our work area per year is higher than 22 ha, we will save money by owning this manure spreader. This is a very small manure spreader with an implement width of only 9 m. If we decided to get a more expensive manure spreader, the break-even hectare would increase. For the slurry spreader, the break-even hectare is 18 ha, but we only need it for 8 ha. So, it would be better to hire a contractor to spread slurry.

If we look at the disc harrow and the tine cultivator, we see that contractor rates are very competitive. We would need to disc harrow 95 ha with a 3 m wide disc harrow to beat the contractor rate. For the tine cultivator we need to cultivate 28 ha with a 3 m wide cultivator to beat the contractor.

Table 51. Break-even analysis for owning and using implements.

			SEEDERS	PLANTERS	FERTILIZERSPREADERS	LIMESPREADERS	SPRAYER
Price	: €	:	13000	29000	15000	39000	29500
Loan duration	: years	:	7	7	7	7	7
Life time	: years	:	20	20	20	20	20
Net interest rate	: %	:	2.0000	2.0000	2.0000	2.0000	2.0000
Interest cost	: €	:	1933	4312	2230	5799	4386
Loan cost	: €	:	14933	33312	17230	44799	33886
Depreciation rate per year	: -	:	0.1000	0.1000	0.1000	0.1000	0.1000
Salvage fraction	: -	:	0.1216	0.1216	0.1216	0.1216	0.1216
Sell price	: €	:	1580	3526	1824	4741	3587
Loan payment	: €	:	13352	29786	15407	40057	30300
Life time depreciation	: €	:	11420	25474	13176	34259	25913
Investment cost	: €	:	24772	55260	28583	74316	56213
Investment cost per year	: €/year	:	1239	2763	1429	3716	2811
Tax, insurance, housing cost	: €/year	:	7	16	8	22	17
Fixed cost per year	: €/year	:	1246	2779	1438	3738	2827
Implement width	: m	:	3.0000	4.5000	15.0000	12.0000	15.0000
Implement speed	: kph	:	10.0000	8.0000	12.0000	12.0000	12.0000
Implement efficiency	: -	:	0.7000	0.6500	0.6300	0.8300	0.8500
Implement capacity	: ha/hour	:	2.1000	2.3400	11.3400	11.9520	15.3000
Implement work area	: ha/year	:	136.2500	78.0000	293.0000	84.2490	451.0000
Implement hours per year	: hours/year	:	64.8810	33.3333	25.8377	7.0489	29.4771
Implement hours life time	: hours	:	1298	667	517	141	590
Repair factor	: -	:	0.0100	0.0100	0.0100	0.0100	0.0100
Repairs per year	: €/year	:	7	15	8	20	15
Repairs per hour	: €/hour	:	0.1002	0.4350	0.2903	2.7664	0.5004
Required HP	: hp	:	85	85	70	140	100
Fuel per hour	: L/hour	:	14.1695	14.1695	11.6690	23.3380	16.6700
Fuel cost per hour	: €/hour	:	18.4912	18.4912	15.2280	30.4561	21.7543
Lubrication cost per hour	: €/hour	:	2.7737	2.7737	2.2842	4.5684	3.2632
Labor cost per hour	: €/hour	:	16.5000	16.5000	16.5000	16.5000	16.5000
Operating cost per hour	: €/hour	:	37.8651	38.1999	34.3025	54.2909	42.0179
Operating cost per ha	: €/ha	:	18.0310	16.3247	3.0249	4.5424	2.7463
Fixed cost per ha	: €/ha	:	9.1441	35.6319	4.9064	44.3644	6.2687
Fixed + op. cost per ha	: €/ha	:	27	52	8	49	9
Fixed + op. cost per hour	: €/hour	:	57	122	90	585	138
Fixed + op. cost per year	: €/year	:	3703	4053	2324	4120	4066
Contract cost per ha	: €/ha	:	77	42	21	21	28
Contract cost per hour	: €/hour	:	162	98	238	251	428
Contract cost per year	: €/year	:	10491	3276	6153	1769	12628
Break-even fixed cost per ha	: €/ha	:	59	26	18	16	25
Break-even ha	: ha/year	:	21	108	80	227	112
Break-even field hours	: hours/year	:	10	46	7	19	7

Table 52. Break-even analysis of owning and using implements.

			HARVESTERS	FORAGEHARVESTERS	POTATOPLANTERS	POTATOHARVESTING	BEETHARVESTIN
Price	: €	:	156000	385000	21000	160000	120000
Loan duration	: years	:	7	7	7	7	7
Life time	: years	:	15	15	20	15	15
Net interest rate	: %	:	2.0000	2.0000	2.0000	2.0000	2.0000
Interest cost	: €	:	23195	57244	3122	23790	17842
Loan cost	: €	:	179195	442244	24122	183790	137842
Depreciation rate per year	: -	:	0.1000	0.1000	0.1000	0.1000	0.1000
Salvage fraction	: -	:	0.2059	0.2059	0.1216	0.2059	0.2059
Sell price	: €	:	32119	79268	2553	32943	24707
Loan payment	: €	:	147076	362976	21569	150847	113135
Life time depreciation	: €	:	123881	305732	18447	127057	95293
Investment cost	: €	:	270957	668708	40016	277905	208428
Investment cost per year	: €/year	:	18064	44581	2001	18527	13895
Tax, insurance, housing cost	: €/year	:	125	310	12	129	96
Fixed cost per year	: €/year	:	18189	44890	2013	18656	13992
Implement width	: m	:	5.0000	6.0000	3.0000	1.8000	3.0000
Implement speed	: kph	:	7.0000	6.0000	8.0000	7.0000	7.0000
Implement efficiency	: -	:	0.8200	0.8200	0.6500	0.8200	0.8200
Implement capacity	: ha/hour	:	2.8700	2.9520	1.5600	1.0332	1.7220
Implement work area	: ha/year	:	150.0000	25.0000	5.0000	5.0000	3.0000
Implement hours per year	: hours/year	:	52.2648	8.4688	3.2051	4.8393	1.7422
Implement hours life time	: hours	:	784	127	64	73	26
Repair factor	: -	:	0.0100	0.0100	0.0100	0.0100	0.0100
Repairs per year	: €/year	:	104	257	11	107	80
Repairs per hour	: €/hour	:	1.9899	30.3072	3.2760	22.0416	45.9200
Required HP	: hp	:	180	650	150	110	185
Fuel per hour	: L/hour	:	30.0060	108.3550	25.0050	18.3370	30.8395
Fuel cost per hour	: €/hour	:	39.1578	141.4033	32.6315	23.9298	40.2455
Lubrication cost per hour	: €/hour	:	5.8737	21.2105	4.8947	3.5895	6.0368
Labor cost per hour	: €/hour	:	16.5000	16.5000	16.5000	16.5000	16.5000
Operating cost per hour	: €/hour	:	63.5214	209.4210	57.3023	66.0609	108.7024
Operating cost per ha	: €/ha	:	22.1329	70.9421	36.7322	63.9381	63.1257
Fixed cost per ha	: €/ha	:	121.2614	1795.6013	402.5171	3731.1196	4663.8995
Fixed + op. cost per ha	: €/ha	:	143	1867	439	3795	4727
Fixed + op. cost per hour	: €/hour	:	412	5510	685	3921	8140
Fixed + op. cost per year	: €/year	:	21509	46664	2196	18975	14181
Contract cost per ha	: €/ha	:	165	165	195	660	290
Contract cost per hour	: €/hour	:	474	487	304	682	499
Contract cost per year	: €/year	:	24750	4125	975	3300	870
Break-even fixed cost per ha	: €/ha	:	143	94	158	596	227
Break-even ha	: ha/year	:	127	477	13	31	62
Break-even field hours	: hours/year	:	44	162	8	30	36

Table 53. Break-even analysis of owning and using implements.

	Unit	MOWERS	TEDDERS	WINDROWERS
Price	€	16000	11000	10000
Loan duration	years	7	7	7
Life time	years	20	20	20
Net interest rate	%	2.0000	2.0000	2.0000
Interest cost	€	2379	1636	1487
Loan cost	€	18379	12636	11487
Depreciation rate per year	-	0.1000	0.1000	0.1000
Salvage fraction	-	0.1216	0.1216	0.1216
Sell price	€	1945	1337	1216
Loan payment	€	16434	11298	10271
Life time depreciation	€	14055	9663	8784
Investment cost	€	30489	20961	19055
Investment cost per year	€/year	1524	1048	953
Tax, insurance, housing cost	€/year	9	6	6
Fixed cost per year	€/year	1533	1054	958
Implement width	m	4.3000	6.0000	4.6000
Implement speed	kph	11.0000	11.0000	11.0000
Implement efficiency	-	0.8300	0.8000	0.8000
Implement capacity	ha/hour	3.9259	5.2800	4.0480
Implement work area	ha/year	135.0000	60.0000	135.0000
Implement hours per year	hours/year	34.3870	11.3636	33.3498
Implement hours life time	hours	688	227	667
Repair factor	-	0.0100	0.0100	0.0100
Repairs per year	€/year	8	6	5
Repairs per hour	€/hour	0.2326	0.4840	0.1499
Required HP	hp	80	60	50
Fuel per hour	L/hour	13.3360	10.0020	8.3350
Fuel cost per hour	€/hour	17.4035	13.0526	10.8772
Lubrication cost per hour	€/hour	2.6105	1.9579	1.6316
Labor cost per hour	€/hour	16.5000	16.5000	16.5000
Operating cost per hour	€/hour	36.7466	31.9945	29.1587
Operating cost per ha	€/ha	9.3601	6.0596	7.2032
Fixed cost per ha	€/ha	11.3585	17.5702	7.0991
Fixed + op. cost per ha	€/ha	21	24	14
Fixed + op. cost per hour	€/hour	81	125	58
Fixed + op. cost per year	€/year	2797	1418	1931
Contract cost per ha	€/ha	65	22	22
Contract cost per hour	€/hour	255	116	89
Contract cost per year	€/year	8775	1320	2970
Break-even fixed cost per ha	€/ha	56	16	15
Break-even ha	ha/year	28	66	65
Break-even field hours	hours/year	7	13	16

The break-even hectare is very high even for very small implements. In my own FS games, I hardly ever have more than 50 ha, hence the economic analysis indicates that a number of field jobs should be contracted, in particular harvesting jobs.

The economy of baling involves a different approach. It is described in the next subsection.

14.3 Baling implements

Contract rates for baling are often given as a fee per bale and differs for hay and silage, and for round bales and square bales. This is addressed in the script RealNumbersBalingEquipmentEconomy.lua.

Table 54. Typcial contract baling fees in Denmark. €/bale.

```
RN.contractRatePerBale.SILAGEROUNDBALE         = 19;  -- contract fee per bale
RN.contractRatePerBale.SILAGESQUAREBALE        = 22;  -- contract fee per bale
RN.contractRatePerBale.DRYGRASSROUNDBALE       =  9;  -- contract fee per bale
RN.contractRatePerBale.DRYGRASSSQUAREBALE      = 11;  -- contract fee per bale
RN.contractRatePerBale.STRAWROUNDBALE          =  7;  -- contract fee per bale
RN.contractRatePerBale.STRAWSQUAREBALE         =  8;  -- contract fee per bale
```

The work capacity of a baler is determined by its throughput (tonnes) per hour. By default all balers are set to have a throughput of 16 tonnes per hour (Table 55).

Table 55. Throughput performance of balers in Tonnes/hour.

```
RN.throughPutTonPerHour.SILAGEROUNDBALE        = 16;  --Ton/hour
RN.throughPutTonPerHour.SILAGESQUAREBALE       = 16;  --Ton/hour
RN.throughPutTonPerHour.DRYGRASSROUNDBALE      = 16;  --Ton/hour
RN.throughPutTonPerHour.DRYGRASSSQUAREBALE     = 16;  --Ton/hour
RN.throughPutTonPerHour.STRAWROUNDBALE         = 16;  --Ton/hour
RN.throughPutTonPerHour.STRAWSQUAREBALE        = 16;  --Ton/hour
```

The input parameters for calculating baling costs are shown in Table 56.

Table 56. Input parameters for analysis of baling eqconomy. More bale types are included in the script.

```
RN.equipment.price["SILAGEROUNDBALE"]                   = 76000; --   €
RN.equipment.loanTime["SILAGEROUNDBALE"]                = RN.loanYears;     -- years
RN.equipment.lifeTime["SILAGEROUNDBALE"]                = 20;     -- years
RN.equipment.depreciationRate["SILAGEROUNDBALE"]        = 0.1;
RN.equipment.efficiency["SILAGEROUNDBALE"]              = 0.80;
RN.equipment.workArea["SILAGEROUNDBALE"]        = RN.fieldArea["SILAGEROUNDBALE"];
RN.equipment.neededHP["SILAGEROUNDBALE"]                = 110; -- hp
RN.equipment.fuelPerHourPerHP["SILAGEROUNDBALE"]        = RN.fuelPerHourPerHP;
RN.equipment.wrappingPerBale["SILAGEROUNDBALE"]         = 7.5; -- €/bale
RN.equipment.plasticPerBale["SILAGEROUNDBALE"]          = 3;    -- €/bale

RN.equipment.price["STRAWSQUAREBALE"]                   = 105000; --   €
RN.equipment.loanTime["STRAWSQUAREBALE"]                = RN.loanYears;     -- years
RN.equipment.lifeTime["STRAWSQUAREBALE"]                = 20;     -- years
RN.equipment.depreciationRate["STRAWSQUAREBALE"]        = 0.1;
RN.equipment.efficiency["STRAWSQUAREBALE"]              = 0.80;
RN.equipment.workArea["STRAWSQUAREBALE"]        = RN.fieldArea["STRAWSQUAREBALE"];
RN.equipment.neededHP["STRAWSQUAREBALE"]                = 140; -- hp
RN.equipment.fuelPerHourPerHP["STRAWSQUAREBALE"]        = RN.fuelPerHourPerHP;
RN.equipment.wrappingPerBale["STRAWSQUAREBALE"]         = 0;
RN.equipment.plasticPerBale["STRAWSQUAREBALE"]          = 0;
```

The total cost of baling with own equipment includes the fixed cost of owning the equipment, the operating cost of the equipment itself (repair, field, lubrication, labor) and the cost of supplies (wrapping cost, plastic cost).

Table 57. Cost of baling with own equipment.

			SILAGE BALING		DRYGRASS BALING		STRAW BALING	
			Round	Square	Round	Square	Round	Square
Price	: €	:	76000	105000	76000	105000	76000	105000
Loan time	: years	:	7	7	7	7	7	7
Life time	: years	:	20	20	20	20	20	20
Net interest rate	: %	:	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000
Interest cost	: €	:	11300	15612	11300	15612	11300	15612
Loan cost	: €	:	87300	120612	87300	120612	87300	120612
Depreciation rate per year	: -	:	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
Salvage fraction	: -	:	0.1216	0.1216	0.1216	0.1216	0.1216	0.1216
Sell price	: €	:	9240	12766	9240	12766	9240	12766
Loan payment	: €	:	78060	107846	78060	107846	78060	107846
Life time depreciation	: €	:	66760	92234	66760	92234	66760	92234
Investment cost	: €	:	144820	200081	144820	200081	144820	200081
Investment cost per year	: €/year	:	7241	10004	7241	10004	7241	10004
Tax, insurance, housing cost	: €/year	:	43	59	43	59	43	59
Fixed cost per year	: €/year	:	7284	10063	7284	10063	7284	10063
Partial fixed cost per year	: €/year	:	1444	1994	2887	3989	2953	4080
Throughput	: Ton/hour	:	16.0000	16.0000	16.0000	16.0000	16.0000	16.0000
Ton per ha	: Ton/ha	:	21.5190	21.5190	9.2795	9.2795	6.2592	6.2592
Implement efficiency	: -	:	0.8000	0.8000	0.8000	0.8000	0.8000	0.8000
Implement capacity	: ha/hour	:	0.5948	0.5948	1.3794	1.3794	2.0450	2.0450
Implement work area	: ha/year	:	36.6667	36.6667	73.3333	73.3333	75.0000	75.0000
Implement hours per year	: hours/year	:	61.6429	61.6429	53.1637	53.1637	36.6750	36.6750
Implement hours life time	: hours	:	1233	1233	1063	1063	734	734
Repair factor	: -	:	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100
Repairs per year	: €/year	:	38	53	38	53	38	53
Repairs per hour	: €/hour	:	0.6165	0.8517	0.7148	0.9875	1.0361	1.4315
Required HP	: hp	:	110	140	110	140	110	140
Fuel per hour	: L/hour	:	18.3370	23.3380	18.3370	23.3380	18.3370	23.3380
Fuel cost per hour	: €/hour	:	23.9298	30.4561	23.9298	30.4561	23.9298	30.4561
Lubrication cost per hour	: €/hour	:	3.5895	4.5684	3.5895	4.5684	3.5895	4.5684
Labor cost per hour	: €/hour	:	16.5000	16.5000	16.5000	16.5000	16.5000	16.5000
Operating cost per hour	: €/hour	:	44.6357	52.3762	44.7340	52.5120	45.0554	52.9560
Operating cost per year	: €/year	:	2751.4758	3228.6215	2378.2248	2791.7314	1652.4061	1942.1612
Operating cost per ha	: €/ha	:	75.0402	88.0533	32.4303	38.0691	22.0321	25.8955
Operating cost per bale	: €/bale	:	2.1330	4.3508	1.0415	2.1251	0.7177	1.4663
Fixed cost per ha	: €/ha	:	39.3710	54.3942	39.3710	54.3942	39.3710	54.3942
Fixed cost per bale	: €/bale	:	1.1191	2.6876	1.2644	3.0364	1.2825	3.0800
Fixed + op. cost per ha	: €/ha	:	114	142	72	92	61	80
Fixed + op. cost per year	: €/year	:	4195	5223	5265	6781	4605	6022
Fixed + op. cost per bale	: €/bale	:	3	7	2	5	2	5
Supply cost per bale	: €/bale	:	11	11	0	0	0	0
Supply cost per ha	: €/ha	:	369	213	0	0	0	0
Operating and supply cost per ha	: €/ha	:	444	301	32	38	22	26
Fixed + op. + supply cost per ha	: €/ha	:	484	355	72	92	61	80
Contract cost per bale	: €/bale	:	19	22	9	11	7	8
Contract cost per ha	: €/ha	:	668	445	280	197	215	141
Contract cost per year	: €/year	:	24509	16326	20552	14451	16117	10596
Break-even fixed cost per ha	: €/ha	:	224	145	248	159	193	115
Break-even ha	: ha/year	:	6	14	12	25	15	35

We notice that the baler field capacity varies depending on if we bale silage, hay or straw. This is because the mass of the baling material varies while the throughput capacity is the same. Since the same baler is used for making silage, hay and straw bales, the fixed cost per bale is influenced by how many bales are made of each type. Hence, the cost of silage baling in Table 57 is influenced by the hectares baled of hay and straw and vice versa. The break-even hectare for square balers is a little more than two times that for round balers.

15 Cost of crop production

A new script has been added to make estimates of cost of production for crops. It is called RealNumbersCropProductionCost.lua. It produces the predictions shown in Table 58.

Table 58. Estimating crop production cost. Rustic acres, US. By Cazz64.

€/Ha		Gross income	Supply costs	Net income	Field work	Field rent	Profit	Feed cost €/L
BARLEY	: €/Ha	687	307	381	704	381	-704	0.169
CABBAGE	: €/Ha	17089	884	16205	5103	381	10721	0.060
CANOLA	: €/Ha	624	639	-15	704	381	-1099	0.509
CARROT	: €/Ha	12783	656	12126	5103	381	6643	0.076
CLOVER	: €/Ha	1273	523	750	274	381	96	0.016
COFFEE	: €/Ha	23637	924	22713	0	381	22333	0.415
COTTON	: €/Ha	2041	660	1381	0	381	1001	0.119
DRYGRASS	: €/Ha	1073	444	628	274	381	-26	0.014
GRASS	: €/Ha	1370	444	926	274	381	271	0.013
HEMP	: €/Ha	4351	547	3804	0	381	3423	0.158
HOPS	: €/Ha	20906	1607	19299	0	381	18918	0.702
LETTUCE	: €/Ha	23813	553	23260	5103	381	17776	0.052
MAIZE	: €/Ha	1623	372	1251	762	381	108	0.073
MILLET	: €/Ha	284	199	85	704	381	-1000	0.309
MUSTARD	: €/Ha	617	359	258	5103	381	-5225	4.746
OAT	: €/Ha	503	269	234	704	381	-851	0.167
OILSEEDRADISH	: €/Ha	0	112	-112	274	381	-767	0.108
ONION	: €/Ha	20878	519	20359	5103	381	14875	0.071
POPLAR	: €/Ha	1128	520	608	0	381	227	0.018
POPPY	: €/Ha	6960	279	6681	0	381	6301	0.024
POTATO	: €/Ha	9195	1266	7929	4509	381	3040	0.113
REDCABBAGE	: €/Ha	17089	884	16205	5103	381	10721	0.060
RICE	: €/Ha	1958	876	1082	0	381	701	0.057
RYE	: €/Ha	494	407	86	704	381	-998	0.407
SOYBEAN	: €/Ha	1251	278	974	704	381	-111	0.218
SUGARBEET	: €/Ha	932	1037	-105	5103	381	-5589	0.121
SUGARCANE	: €/Ha	2536	864	1672	5441	381	-4149	0.054
SUNFLOWER	: €/Ha	712	270	442	762	381	-701	0.266
TOBACCO	: €/Ha	14596	1303	13292	725	381	12187	0.640
WHEAT	: €/Ha	775	480	295	704	381	-789	0.199

The gross income is simply the crop sell price per liter multiplying by the liters produced per hectare. Supply cost per hectare is the sum of costs per hectare for seed, fertilizer and chemicals for crop protection. Net income is Gross income minus Supply cost. Field work is the cost per hectare of all field work required for the crop (manure spreading, plowing, cultivating, seeding, rolling, fertilizing, crop spraying, harvesting). For some specialty crops the field cost is unknown. More will be said about calculating field work cost in a moment.

Net profit is calculated by subtracting cost of field work and cost of field rent from Net income. If you do rent the field, then the cost of rent is a real cost. If you own the field, you still have to subtract the cost of rent because you have to compare the crop profit to what income you could have had by renting out the field to another farmer. For many crops, the profit is negative, typically indicating that the field work is too expensive. In the present analysis this might arise because too much field work is done for a given crop. Some crops are only profitable in farming with no tillage and direct seeding, and perhaps minimal fertilizing with no manure or slurry spreading.

Profit depends also on crop sell prices and yield. So the economy may look quite different in another part of the world.

Table 59. Estimating crop production cost. Sandy Bay, UK. By Oxygendavid.

€/Ha		Gross income	Product costs	Net income	Field work	Field rent	Profit	Feed cost €/L
BARLEY	: €/Ha	920	300	620	385	418	-183	0.071
CANOLA	: €/Ha	1238	639	599	385	418	-204	0.187
COTTON	: €/Ha	42	660	-618	0	418	-1036	1.532
DRYGRASS	: €/Ha	1073	444	628	215	418	-5	0.013
DRYLUCERNE	: €/Ha	683	527	157	0	418	-261	0.016
GRASS	: €/Ha	1370	444	926	215	418	292	0.012
LUCERNE	: €/Ha	970	539	431	0	418	13	0.014
MAIZE	: €/Ha	845	512	333	392	418	-476	0.126
OAT	: €/Ha	862	244	618	385	418	-185	0.047
OILSEEDRADISH	: €/Ha	0	112	-112	215	418	-746	0.092
POPLAR	: €/Ha	1128	520	608	0	418	189	0.018
POTATO	: €/Ha	7970	1194	6776	4430	418	1928	0.101
RYE	: €/Ha	317	407	-90	385	418	-893	0.259
SOYBEAN	: €/Ha	848	278	571	385	418	-232	0.215
SUGARBEET	: €/Ha	2222	1037	1184	4975	418	-4209	0.060
SUGARCANE	: €/Ha	2536	864	1672	5362	418	-4108	0.054
SUNFLOWER	: €/Ha	726	270	456	392	418	-353	0.128
WHEAT	: €/Ha	1411	463	948	385	418	145	0.084

Table 60. Estimating crop production cost. Felsbrunn by MC, DE.

€/Ha		Gross income	Product costs	Net income	Field work	Field rent	Profit	Feed cost €/L
BARLEY	: €/Ha	1007	315	692	1190	625	-1123	0.143
CABBAGE	: €/Ha	14223	884	13339	6366	625	6348	0.073
CANOLA	: €/Ha	1294	639	655	1190	625	-1160	0.326
CARROT	: €/Ha	11700	995	10705	6366	625	3714	0.098
COTTON	: €/Ha	42	895	-853	0	625	-1478	2.080
DRYGRASS	: €/Ha	1073	444	628	751	625	-747	0.023
GRASS	: €/Ha	1370	444	926	751	625	-450	0.022
HOPS	: €/Ha	10611	1607	9004	0	625	8379	0.719
LETTUCE	: €/Ha	30050	553	29497	6366	625	22506	0.064
MAIZE	: €/Ha	1638	511	1127	2014	625	-1512	0.188
MILLET	: €/Ha	284	201	83	1190	625	-1732	0.476
OAT	: €/Ha	718	244	474	1190	625	-1341	0.128
OILSEEDRADISH	: €/Ha	0	112	-112	751	625	-1488	0.189
ONION	: €/Ha	9437	1221	8216	6366	625	1225	0.096
POPLAR	: €/Ha	1128	520	608	0	625	-17	0.018
POPPY	: €/Ha	6960	275	6685	0	625	6060	0.024
POTATO	: €/Ha	7071	1194	5877	4923	625	329	0.106
REDCABBAGE	: €/Ha	10957	884	10073	6366	625	3083	0.073
RYE	: €/Ha	497	374	124	1190	625	-1692	0.336
SORGHUM	: €/Ha	745	308	437	1190	625	-1378	0.281
SOYBEAN	: €/Ha	1024	324	700	1190	625	-1116	0.407
SPELT	: €/Ha	1278	458	820	1190	625	-995	0.168
SUGARBEET	: €/Ha	1976	877	1099	6366	625	-5892	0.071
SUGARCANE	: €/Ha	51	864	-813	5855	625	-7293	4.275
SUNFLOWER	: €/Ha	635	267	369	2014	625	-2270	0.452
TOBACCO	: €/Ha	3514	1303	2211	1132	625	454	0.956
TRITICALE	: €/Ha	929	423	506	1190	625	-1309	0.206
WHEAT	: €/Ha	1278	458	820	1190	625	-995	0.168

In some cases, you grow the crop purely for selling. In other cases, you grow it to have feed for animals. Even though some crops may not be profitable for selling, they may be profitable compared to the purchase price of animal feed. The rightmost column shows the cost of feed production per liter.

$$Feed\ cost\ per\ liter = \frac{Supply\ cost\ per\ ha + Field\ work\ per\ ha}{Crop\ yield\ per\ ha}$$

Feed cost of own production must be compared to the purchase price of feed mix.

Table 61. Feed prices.

FORAGE_MIXING price	=	100.3782 €/1000 L -- Rusty Acre
PIGFOOD price	=	382.9543 €/1000 L -- Rusty Acre
FORAGE_MIXING price	=	49.3022 €/1000 L -- Sandy Bay
PIGFOOD price	=	103.5403 €/1000 L -- Sandy Bay
FORAGE_MIXING price	=	53.9639 €/1000 L -- Felsbrunn
PIGFOOD price	=	194.2460 €/1000 L -- Felsbrunn

Although most cereal crops have a negative profit estimate for selling, you may still be able to use them to make pigfeed at a competitive price.

The cost of field work for each crop is rather involved since the cost of each implement depends on the total hectares on which the implement is used. It is therefore necessary to set up a complete farming operation, where the total number of hectares for all crops are known. Then we also need to specify what field work is to be done for each crop and how many times. Such information is defined in the script RealNumbersMyFieldCrops.lua.

Table 62. Crop field area and field work setup. Here for barley. All other crops are done similarly.

```
RN.myFieldCrops["BARLEY"] = {};
RN.myFieldCrops["BARLEY"]["fields"]              = {};
RN.myFieldCrops["BARLEY"]["myFieldArea"]         = {};
RN.myFieldCrops["BARLEY"]["totalArea"]           = 0;
RN.myFieldCrops["BARLEY"]["fruitName"]           = "BARLEY";
RN.myFieldCrops["BARLEY"]["fields"]              = {1};
RN.myFieldCrops["BARLEY"]["myFieldArea"]         = {10};
RN.myFieldCrops["BARLEY"]["manure"]              = 0;
RN.myFieldCrops["BARLEY"]["slurry"]              = 1;
RN.myFieldCrops["BARLEY"]["lime"]                = 0.333;
RN.myFieldCrops["BARLEY"]["plow"]                = 0;
RN.myFieldCrops["BARLEY"]["subsoil"]             = 0;
RN.myFieldCrops["BARLEY"]["tineharrow"]          = 1;
RN.myFieldCrops["BARLEY"]["discharrow"]          = 0;
RN.myFieldCrops["BARLEY"]["powerharrow"]         = 0;
RN.myFieldCrops["BARLEY"]["seed"]                = 1;
RN.myFieldCrops["BARLEY"]["plant"]               = 0;
RN.myFieldCrops["BARLEY"]["potatoplant"]         = 0;
RN.myFieldCrops["BARLEY"]["solidfertilizer"]     = 1;
RN.myFieldCrops["BARLEY"]["liquidfertilizer"]    = 1;
RN.myFieldCrops["BARLEY"]["spraychemicals"]      = 1;
RN.myFieldCrops["BARLEY"]["rolling"]             = 1;
RN.myFieldCrops["BARLEY"]["mechanicalweeding"]   = 0;
RN.myFieldCrops["BARLEY"]["cerealharvest"]       = 1;
RN.myFieldCrops["BARLEY"]["rowharvest"]          = 0;
RN.myFieldCrops["BARLEY"]["beetharvest"]         = 0;
RN.myFieldCrops["BARLEY"]["potatoharvest"]       = 0;
RN.myFieldCrops["BARLEY"]["forageharvest"]       = 0;
RN.myFieldCrops["BARLEY"]["mowing"]              = 0;
RN.myFieldCrops["BARLEY"]["windrow"]             = 0;
RN.myFieldCrops["BARLEY"]["tedding"]             = 0;
RN.myFieldCrops["BARLEY"]["bale"]                = 1;
RN.myFieldCrops["BARLEY"]["balewrap"]            = 0;
RN.myFieldCrops["BARLEY"]["balecollect"]         = 1;
```

An example is shown for Barley in Table 62. There is a total of 10 ha with barley. No manure is applied, slurry is applied one time. It is not plowed but cultivated once with a tine cultivator. It is seeded once, and solid and liquid fertilizer are applied once each. It is sprayed and rolled once and harvested with a combine only once. The straw is baled without windrowing and collected. Lime is applied once every three years. This cost is spread evenly over each year by entering 0.333 as the number of applications per year. Similar definitions must be made for all crops on the farm.

We can now calculate how many hectares we need to plow, cultivate, fertilize and so on. As an example, we will consider a Farm on Sandy Bay by Oxygendavid, where all animal pens are filled to max capacity. This means a lot of feed and a lot of hectares.

Table 63. Number of hectares with different crops and the number of hectares on which different implements are used.

BARLEY	=	25.0000	ha
CANOLA	=	0.0000	ha
COTTON	=	0.0000	ha
GRASS	=	25.0000	ha
LUCERNE	=	20.0000	ha
MAIZE	=	35.0000	ha
OAT	=	25.0000	ha
OILSEEDRADISH	=	50.0000	ha
POPLAR	=	0.0000	ha
POTATO	=	5.0000	ha
RYE	=	0.0000	ha
SOYBEAN	=	40.0000	ha
SUGARBEET	=	3.0000	ha
SUGARCANE	=	0.0000	ha
SUNFLOWER	=	0.0000	ha
WHEAT	=	25.0000	ha
manure	=	75.0000	ha
slurry	=	8.0000	ha
lime	=	84.2490	ha
plow	=	55.0000	ha
subsoil	=	11.2500	ha
tineharrow	=	94.2500	ha
discharrow	=	125.0000	ha
powerharrow	=	0.0000	ha
seed	=	136.2500	ha
plant	=	78.0000	ha
potatoplant	=	5.0000	ha
solidfertilizer	=	293.0000	ha
liquidfertilizer	=	293.0000	ha
spraychemicals	=	158.0000	ha
rolling	=	86.2500	ha
mechanicalweeding	=	0.0000	ha
cerealharvest	=	115.0000	ha
rowharvest	=	35.0000	ha
beetharvest	=	3.0000	ha
potatoharvest	=	5.0000	ha
forageharvest	=	0.0000	ha
mowing	=	135.0000	ha
windrow	=	135.0000	ha
tedding	=	60.0000	ha
bale	=	210.0000	ha
balewrap	=	75.0000	ha
balecollect	=	210.0000	ha
Total crop area	=	253.0000	ha

We see that we need to spray manure on 75 hectare and slurry on only 8 ha. In Table 50 these hectares are used to calculate the cost per hectare of manure and slurry spreading. The same is the case for all implements used for a given crop. Adding up the cost of all implements used on barley fields will then tell of the cost of field work for barley. We notice that the cost of each implement is based on the total hectares not just the barley hectares.

We needed 253 ha, but there is “only” 96.7 ha on Sandy Bay. So it is not a very realistic scenario having the animal pens filled to capacity.

16 Planning a farm.

We will use all the forecasting information to plan a farming operation. We will consider Sandy Bay by Oxygen David.

Animal	Max pen capacity	Number of breeding animals
Pigs	500	32
Cows	500	250
Sheep	500	360

We obtain the following estimates for feed amount and field hectares.

Table 64. Feed and hectare need for pigs.

```
Yorkshire
Number of mature animals            =       32
Number of offsprings                =      832      per year
Average weight                      =       62      kg
Average weight gain                 =        1.0035 kg/day
Slaughter age                       =      120      days
Slaughter weight                    =      122      kg
Herd manure per year                =   799618      L/year
Herd slurry per year                =   479771      L/year
Water per year                      =   369054      L/year
Herd feed intake                    =   369054      kg/year
Herd trough feed                    =   369054      kg/year
Feedmix density                     =        0.7465 kg/L
Herd Feedmix volume                 =   494380      L/year
Herd trough cereal                  =   123595      L/year
Herd trough maize                   =   247190      L/year
Herd trough soybean                 =   123595      L/year
Herd bedding straw                  =   699143      L/year
Round straw bales                   =      466      Bales/year
Square straw bales                  =      269      Bales/year
Wheat hectares                      =       12.1952 Ha
Maize hectares                      =       34.3663 Ha
Soybean hectares                    =       40.0736 Ha
Straw hectares                      =       15.2851 Ha
```

For pigs all feed is provided in the trough.

Table 65. Feed and hectare need for cows.

```
Holstein
Number of mature animals            =      250
Number of offsprings, males         =       25
Number of offsprings, females       =      225
Average weight males                =      268      kg
Average weight females              =      175      kg
Average weight gain, males          =        1.2452 kg/day
Average weight gain, females        =        0.7356 kg/day
```

Slaughter age	=	365	days
Slaughter weight, male	=	495	kg
Slaughter weight, female	=	309	kg
Herd manure per year	=	1397507	L/year
Herd slurry per year	=	2215559	L/year
Water per year	=	13403576	L/year
Herd feed intake	=	5440275	kg/year
Herd trough feed	=	544027	kg/year
TMR density	=	0.2200	kg/L
Herd TMR volume	=	2472852	L/year
Herd trough silage	=	618213	L/year
Herd trough hay	=	1236426	L/year
Herd trough straw	=	618213	L/year
Herd bedding straw	=	1965385	L/year
Herd total straw	=	2583598	L/year
Round straw bales	=	1722	Bales/year
Square straw bales	=	994	Bales/year
Round hay bales	=	824	Bales/year
Square hay bales	=	476	Bales/year
Round silage bales	=	412	Bales/year
Square silage bales	=	238	Bales/year
Straw hectares	=	56.4840	Ha
Hay hectares	=	26.6486	Ha
Silage hectares	=	11.7939	Ha

Table 66. Feed and hectare need for sheep.

Dorset			
Number of mature animals	=	360	
Number of offsprings	=	558	
Average weight	=	24	kg
Average weight gain	=	0.1635	kg/day
Slaughter age	=	240	days
Slaughter weight	=	44	kg
Water per year	=	472266	L/year
Herd feed intake	=	1003564	kg/year
Herd trough feed	=	100356	kg/year
TMR density	=	0.2850	kg/L
Herd TMR volume	=	352128	L/year
Herd trough grass	=	176064	L/year
Herd trough hay	=	176064	L/year
Round grass bales	=	117	Bales/year
Square grass bales	=	68	Bales/year
Round hay bales	=	117	Bales/year
Square hay bales	=	68	Bales/year
Hay hectares	=	3.7947	Ha
Grass hectares	=	3.3588	Ha

For cows and sheep, the trough feed is set to 10% of annual feed intake. 90% is obtained by grazing.

We can now sum up the need for different feed types.

Table 67. Crop field sizes needed to meet feed consumption.

Crop	Field area	Unit
Cereal	12.5	ha
Maize	35	ha
Soybean	40	ha
Hay	31	ha
Silage	12	ha
Grass	35	ha
Straw	73	ha

We see that the number of hectares needed is greatly increased by using maize and soybean in pigfeed and by providing straw for cow bedding. If you are playing on a map where yield of maize and soybean is low, then it might be wise to add other crops into the pig feed mix such as canola and potato. About 75% of the straw need is for cow bedding. If you drop straw for cow bedding in all seasons but winter, you would be able to reduce the need to straw considerably.

Table 68. Estimating crop production cost. Sandy Bay, UK.

€/Ha		Gross income	Supply costs	Net income	Field work	Field rent	Profit	Feed cost €/L
BARLEY	: €/Ha	920	300	620	385	418	-183	0.071
CANOLA	: €/Ha	1238	639	599	385	418	-204	0.187
COTTON	: €/Ha	42	660	-618	0	418	-1036	1.532
DRYGRASS	: €/Ha	1073	444	628	215	418	-5	0.013
DRYLUCERNE	: €/Ha	683	527	157	0	418	-261	0.016
GRASS	: €/Ha	1370	444	926	215	418	292	0.012
LUCERNE	: €/Ha	970	539	431	0	418	13	0.014
MAIZE	: €/Ha	845	512	333	392	418	-476	0.126
OAT	: €/Ha	862	244	618	385	418	-185	0.047
OILSEEDRADISH	: €/Ha	0	112	-112	215	418	-746	0.092
POPLAR	: €/Ha	1128	520	608	0	418	189	0.018
POTATO	: €/Ha	7970	1194	6776	4430	418	1928	0.101
RYE	: €/Ha	317	407	-90	385	418	-893	0.259
SOYBEAN	: €/Ha	848	278	571	385	418	-232	0.215
SUGARBEET	: €/Ha	2222	1037	1184	4975	418	-4209	0.060
SUGARCANE	: €/Ha	2536	864	1672	5362	418	-4108	0.054
SUNFLOWER	: €/Ha	726	270	456	392	418	-353	0.128
WHEAT	: €/Ha	1411	463	948	385	418	145	0.084

Comparing with the crop production cost, we conclude that the need for cereal is best met by oat, barley, and wheat while rye is too expensive. Grass and Lucerne/alfalfa have comparable cost of production and can both be used for feeding cows and sheep.

We should not forget, that the cost of field work is based on a fairly full amount of field work and that the cost can be reduced by going to different style of farming, such as no tillage, direct seeding, and so on. We also should not forget that the cost of field work assumes that we use the smallest and cheapest equipment in the game. All the work listed in Table 63 are to be done with 3-meter-wide equipment. To justify larger equipment, you may have to consider doing contract work for other farmers using your equipment.

A rule of thumb says that you have the right size implements if you can do all spring tillage and seeding in 20 days and all harvest in 25 days[5].

In future mod releases we will look into cost of production for animals.

17 End notes

A lot more could have been done, and things could have been more streamlined with nice HUDs. But better stop at 80%, as the remaining 20% takes 80% of the time. I hope you will enjoy simulating real-life farming, and not the least, tweaking the mod to your game.

Figure 24. The first rain in 120 days.

[5] William Edwards, Farm machinery selection a3-28. Iowa State University Extension and Outreach.

18 Appendix

Table 69. Pig terminology[6].

Term	Description
Barrow	Male pig castrated before reaching sexual maturity.
Boar	Male hog or pig with intact testicles.
Colostrum	First milk produced by the sow; it provides immunity to the baby pigs for the first few weeks.
Creep Feed	Creep feed is a starter ration for piglets. It is high in protein, usually from sugar and milk proteins for high energy.
Cull sow	Full-grown female sold for slaughter. Usually showing poor physical characteristics that make her undesirable for breeding.
Culling	This is the process of removing any undesirable animals from the herd normally for health or performance issues.
Dam	Mother sow
Estrus	Also known as "going into heat" or "in heat", is the period when the sow or gilt is sexually receptive. Usually every 21 days, with gilts starting their first estrus between 5 and 8 months depending on the breed of pig.
Farrow	To give birth to piglets. Farrow (as a noun) is a litter.
Farrow to Finish	This means you raise the pig from birth to butchering size.
Feeder Pig	These are young pigs, usually 6 – 10 weeks old that are produced by one farm then purchased and finished on another farm. It also refers to any piglet that is being raised for pork.
Finish Hog	A pig that has been raised to market weight and is ready for butchering.
Finishing	Feeding a pig out to reach market weight.
Gestation	Pregnancy, lasting about 114 days in swine. Also known to some as 3 months, 3 weeks, and 3 days.
Gilt	A gilt or gilts are young females that have not yet produced a litter.
Grower Pig	(Finishing pig)- animal weighing between 40 and 220 lbs. that is being fed for slaughter
Hog	A pig that weighs at least 120 pounds
In Pig	When a sow is pregnant, she is in pig.
Lactation	The time when a sow is producing milk and feeding piglets.
Litter	All the offspring from a single farrowing.
Mummy	A piglet that is born dead but hasn't fully developed. The piglet died too late in the pregnancy for the sow's body to reabsorb it.
Open	A gilt or sow that did not conceive at breeding or may have absorbed the pregnancy.
Runt	Small or weak pig in a litter. Runts should be culled out of the herd.
Scours	Diarrhea. Severe scours can cause death.
Service	The introduction of semen into the uterus of a sow or gilt. This can be natural (done by a boar) or by artificial insemination.
Shoat	A young pig that has not yet reached 120 pounds.
Sow	Female which has farrowed at least once.
Swine	General term used for all pigs
Wallow	Water-filled depression or container large enough for pigs to lay in to cool off during warm weather
Weaning	Removing young from their mother. Weaning can take place anywhere from 3 to 8 weeks depending on the farmers growing system. Little Pig Farm recommends leaving the piglets to nurse for a minimum of 6 weeks.
Weanling	A piglet recently removed from the sow and typically weighing between 25 and 40 pounds.

[6] http://littlepigfarm.com/swine-terminology/

Table 70. Dairy cow terminology.

Term	Description
Abomasum	True stomach of the ruminant animal.
Beast	General descriptive term for an adult bovine.
Baby beef	Slaughter cattle weighing 700 to 1000lbs (approximately 315 to 450kgs) at 9 to 15 months of age grading good or better for quality.
Beefling	A fat young cattle beast weighing 500kg (approx. 1100lbs) at one and a half to two years of age.
Bobby calf	Calf slaughtered whilst only a few days old.
Bob veal calf	One to three weeks old, sold for baby veal, often the male calves from dairy farms, average weight 150lbs (68kgs).
Body condition score	(BCS) A way for producers to classify their animals, useful in managing feeding of classes of animals.
Bull calf	Male young animal up to stage of yearling.
Bull	Male bovine animal of breeding age, usually over one year old.
Bullock	Mature castrated male cattle destined for meat production.
Bull beef	From entire animals instead of the fatter steer or bullock.
Calf	Bovine animal less than a year old. (In some legislation six months old or even less.
Calving	The act of giving birth in cattle.
Colostrum	First milk following calving. High in fat, protein, and immunoglobulins that may be directly absorbed by the newborn calf in its first 24 hours of life.
Concentrates	The generic term for all non-forage feeds. High energy or high protein feeds consisting primarily of the seed of the plant, but without stems and leaves.
Cow	A female that has had one or more calves.
Cull	To remove a cow from the herd. Culling reasons include voluntary culling of cows for low milk production, or involuntary culling of cows for reasons of health or injury.
Cull cow	A cow that has been removed from the dairy herd or beef breeding herd to be sent to slaughter.
Dairy calf	Calf of a mating between a bull and a cow both of dairy breeds.
Veal calf	Specially reared, grown quickly and fed on special food aged up to three months.
Dairy cow	Cow of a breed specifically defined as being for milk production, as distinct from beef or dual-purpose breeds.
Dam	Mother of a calf.
Dry cow	A cow in the two - three month period between the end of lactation and the subsequent calving. Cows in which calving is imminent are close-up dry cows or are freshening. Also refers to a mature cow that is not lactating whatever the reason.
Fat stock	(Finished Stock) Beef animals that are ready for slaughter.
Flush system	A manure removal system in which an area is cleaned by high volumes of fresh water, or gray water that is recycled from a manure pit or lagoon.
Forage	Feedstuffs composed primarily of the whole plant, including stems and leaves.
Free-Marten	A female born with a male twin, usually infertile.
Fresh (Cow)	A cow who has recently given birth (or “calved”); the act of giving birth (“calving”) is sometimes described as “freshening”
Freestall barn	A type of housing system where cows are housed in large group pens, with free choice access to feed, water, and comfortable stalls to lay in. Stalls in freestall barns are typically bedded with sand, straw, or some type of mattress.
Gray water	Water that is considered waste and not to be used for cleaning milking systems. Usually including recycled water from a lagoon or milk house waste. Even water only used to cool milk in a plate cooler is considered gray water, though it is often fed to cows to reduce total usage.
Hay	Dried feed consisting of the entire plant. Alfalfa, clover, grass, and oat hay are used in dairy rations.

Heifer	Young female bovine animal up to birth of first calf or in lactation following the first calving. May be qualified as replacement (to enter herd as a replacement for a culled cow), pregnant, maiden or spayed heifer. A springing heifer is in the last one or two weeks of pregnancy. After second calving known as a cow (also second calver).
Heifer calf	A baby female cattle.
In Heat	A cow's fertile period when she may become pregnant, indicated by increased activity and other hallmark signs. Most cows cycling normally come into heat every 21 days. This period is also referred to as "estrus."
Lactation	The stage of a cow's life where she is producing milk after having calved. Most cows lactate for between 300 to 365 days before going into a dry period.
Multiparous	Female animal that has had two or more pregnancies resulting in viable offspring.
Maiden heifer	(Bulling Heifer) - heifer before going the bull.
Maiden	A female, e.g. ewe, gilt, heifer, bitch, mare, of breeding age but not yet mated.
Milk solids	What is left when all water is removed from milk. As it comes from the cow, the solids portion of milk contains approximately 3.7 percent fat and 9 percent solids-not-fat. Milk has typically about 4 % fat and 3.5 % protein. This varies between species.
Omasum	Third stomach compartment of ruminant, responsible for removing water and reducing particle size.
Pasture	Plants, such as grass, grown for feeding or grazing animals. Also serves as a place to feed cattle and other livestock.
Protein concentrates	These are intended for further mixing before feeding with planned proportions of cereals and other feedstuffs either on the farm or in a compound mill. They contain blended high-protein ingredients such as MBM, fishmeal and soybean meal. When mixed with appropriate straights (see below), they can be equivalent in nutritional terms to compounds.
Primiparous	General term for any female animal that has had one pregnancy that resulted in viable offspring.
Replacements	Cattle bred on farm to replace culled breeding stock.
Reticulum	First compartment of the ruminant stomach, also called the hardware compartment and honeycomb.
Rotational grazing	Grazing herd rotates between sectioned-off areas of the pasture to allow pasture to regrow. Also called high density grazing, short duration grazing, block and strip grazing, planned grazing and cell grazing. Perennial grass is best.
Ruminant	An animal with a four chambered stomach.
Set stocking	Cows graze continuously in the same pasture over an extended time. Annual grass species, including clovers are favored.
Silage	A feed prepared by chopping green forage (e.g. grass, legumes, field corn) and placing the material in a structure or container designed to exclude air. The material then undergoes fermentation, retarding spoilage. Silage has a water content of between 60 and 80%.
Sire	The father of an animal.
Suckler cow	The mother of a calf raised for beef production.
Stirk	Regional term for a half-grown animal, heifer or bullock, six to 12 months of age.
Steer	Castrated male animal over one year of age.
Stanchion	A method of restraint of dairy cows where their head is restrained.
Stocking ratio	The number of cows per hectare of grazing area open to the cows at any given time.
Store cattle	Animals for beef which have been reared on one or more farms, and then are sold, either to dealers or other farmers. They are brought for finishing, normally well-grown animals of up to two years of age.
Tie-stall barn	A type of housing system where cows remain in an assigned stall for most of the time, with free choice access to food and water. Cows in tie-stalls (also called "stanchion barns") are milked in their stalls (rather than walking to a milking parlor), and typically turned out to exercise for a portion of the day.
Total Mixed Ration (TMR)	Ration formulated to meet requirements of the cow in which all of the ingredients are blended together in a mixer.
Udder	The organ responsible for milk production.
Yearling	An animal in its second year of age, eg yearling cattle, yearling filly, yearling colt.
Young bulls	Male calves that have not been castrated.

Table 71. Milestones in the life of a cow.

Age	Milestone
1-6 hr	Intake of colostrum, the first cow milk rich in antibodies. Ability to absorb these antibodies declines rapidly and is much reduced after 10 hr. Antibodies must reach intestinal walls before bacteria for the calf to survive.
Day 2	Start of milk replacer feeding, removed from dam. Surplus and frozen colostrum may still be used as calf feed.
Day 11	Initial serving of grain starter mix. Solid feed stimulates development of the rumen. Small amounts of long hay (unchopped hay). No silage.
Day 17	Intake of water starts
Day 36	Initial feed of forage
Week 3-5	Goes from two to one daily milk replacer feed.
Week 6-8	Weaning from milk replacer when a minimum grain starter mix of about 1.5 kg is consumed 3 days in a row.
Month 3	Gradual change from starter to grower grain mix.
Month 4	Pasture grazing starts
Month 6	Transition from weaner to grower. Half the hay (dry matter) can be replaced by equivalent amount of silage
Month 12	Transition from grower to finisher
Month 15	Start of first pregnancy
Year 2	First calving
Year 6	Sold for slaughter and replaced by two-year old heifer

A.J. Heinrichs and C.M. Jones have written a very informative paper on feeding the newborn calf[7]. Additional good readings are listed in the footnotes[8,9,10].

[7] https://extension.psu.edu/feeding-the-newborn-dairy-calf
[8] https://www.aphis.usda.gov/animal_health/nahms/dairy/downloads/bamn/BAMN17_GuideFeeding.pdf
[9] https://www.dairynz.co.nz/media/5787669/dairynz-facts-and-figures.pdf
[10] http://www.aces.edu/pubs/docs/A/ANR-0609/ANR-0609.pdf