Playing with Real-life numbers in Farming Simulator

Version 1.1.4.0

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 frequently 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. Despite the beginners programming style, the mod has not yet shown any adverse effects. The mod uses scripts and will therefore not work on consoles. It has only been tested in Single player mode.

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 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 on the order of 100%. The mod does not attempt to rectify this game behavior. I simply ignore the outliers and use the sales points with prices within a realistic range.

Yours truely,

Kaj-Åge Henneberg
Mar. 20, 2019
Last updated: June 30, 2019
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. With the present update (V. 1.1.0.0), versions of the mod with data for the UK and US Heartland are also ready for publication. The updated version is 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 needs.

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 farm yard. 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.

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.

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 (press leftAlt-ry)`
- `RealNumbersGreenCropYield.lua`
- `RealNumbersSpraying.lua (press leftAlt-rs)`
- `RealNumbersSeedUsage.lua`
- `RealNumbersCropPrices.lua`
- `RealNumbersCommodityPrices.lua`
- `RealNumbersLeasing.lua`
- `RealNumbersAnimalProducts.lua`
- `RealNumbersAnimalCare.lua`
- `RealNumbersAnimalTradePrices.lua`
- `RealNumbersFieldInfo.lua (press leftAlt-rf)`
- `RealNumbersContracts.lua (press leftAlt-rc)`

Some scripts produce summary output by pressing the indicated key strokes. The purpose of each script will be explained in the following sections.

1.4 The components of the current mod (version 1.1.4.0)

The mod 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 (lAlt-ry)`
- `RealNumbersSpraying.lua (lAlt-rs)`
- `RealNumbersCommodityPrices.lua`
- `RealNumbersLeasing.lua`
- `RealNumbersAnimalProducts.lua`
- `RealNumbersAnimalCare.lua`
- `RealNumbersAnimalTradePrices.lua`
- `RealNumbersFieldInfo.lua`
- `RealNumbersFarmland.lua`
- `RealNumbersContracts.lua (lAlt-rc)`
- `RealNumbersVehicleMaintenance.lua (lAlt-rm)`

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 rather arbitrary 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 Recent additions and corrections

Version 1.1.4

In the modDesc, descVersion = 44, to follow patch 1.4. Patch 1.4 added another store item with an index number in the middle of existing numbers. All items with a higher index got their index shifted. As a result, these items had their store price changed. In version 1.1.4, store items are referenced by name rather than by index.

The use of the extermal mod **growthcontrol** has been abandoned. Growthcontrol has not been updated and only defines growth rate for standard crops. Crop growth rate is instead incorporated into this mod in the script **RealNumbersCropYield**.

New extra fruit types:

Asparagus, Luzerne, dryluzerne

New extra fill types:

Asparagus, birne, booze, cherry, cheese, chicken food, cow food, dry luzerne, flour, hmilk, horse food, kies, kirsche, Luzerne windrow, mehl, peat, pellets, pflaume, plum, rum, sheep

food, sugar, yogurt, zucker, round bale clover, square/round bale dry luzerne, square/round bale luzerne

Version 1.1.3

This mod works closely with the fruit, fill and spray types defined on maps. New maps occasionally come out which challenge the mod and sometimes cause the mod to fail due to some undefined parameter. The mod is continuously being updated to (1) more gracefully handle unknown types and (2) include new fruit, fill and spray types. In this version, the following extras are included:

Extra fruit types:

Alfalfa, beans, black beans, cabbage, carrot, clover, coffee, cranberry, hops, incarase grass, lettuce, millet, mustard, onion, peanut, peas, poppy, red cabbage, rice, rye, sorghum, spelt, tobacco, triticale, white cabbage.

Extra fill types:

biomass, butter, cereal bread, coal, compost, gravel, groats, meat, ore, sand, silt, stone, whole grain, clover round bales.

Extra spray type:

Compost.

Extra windrow:

Clover.

Test maps:

Eire, Eureka, Hof Bergmann, Kandelin, Krebach, NF Marsch 1.8, PV19, Suedhemmern, Tervalethi, Valley Crest Farm, Western Australia.

On some maps (Eire, NF Marsch 2.0 and Südhemmern) several hours of game play have been completed. On the others, the tests are limited to a “start-up” test.

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.

1.6 How to use the mod

RealLifeNumbers does most of its job during game startup. Very little interaction with the mod user is implemented. One exception is the script `RealNumbersFieldInfo`. This mod prints information about ownership, crop type, and the size of farmlands and fields on the map. Farmland information is loaded into the game after the scripts in RealLifeNumbers are called. For this reason, this script requires the user to press `leftAlt-rf` (hold down left Alt and press r and f simultaneously) after the game has started. The price of each farmland is set automatically, hence it is only required to press `leftAlt-rf` if a printout to the log file of farmland information is needed.

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 (about 2500 lines) 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.

1.7 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.

1.8 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 four mods, which supports RealLifeNumbers particularly well, **variableSprayUsage** by monteur1, **GrowthControl** and **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-rs** 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).

GrowthControl by **apuehri**/LS-Modcompany allows the user to define the duration of growth stages for each crop type. However, it has not been updated and only handles the standard crops. **Starting from version 1.1.4.0, growthcontrol is no longer used**. Instead, the growth rates of crops (standard + extra fruit) are handled exclusively in FS19_RealLifeNumbers. It is described in the section about the script RealNumbersCropYield. **helperAdmin** allows you to adjust the price per hour paid to helpers. To use real-life wages, values need to be edited in the mod.

VariableBaleCapacity by **sperrgebiet** allows you to redefine the volume of bales. I use it to reset my round bales to 1500 Liters and my square bales to 2600 Liters. These numbers are not default numbers in the mod. 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.

The volume of bales bought in the store has also been changed.

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 can't 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.

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, beans, black beans, cabbage, carrot, clover, coffee, cranberry, hops, incarase grass, lettuce, millet, mustard, onion, peanut, peas, poppy, red cabbage, rice, rye, sorghum, spelt, tobacco, triticale, white cabbage.

The mod reads all fruit types included in a given map. If the same fruit type is also defined in my mod, then my mod parameters 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 1

As illustrated, the format is the same for all fruit types. It is therefore possible for a user to add another fruit type, say hemp, to the mod by copying all lines for f. ex. barley down to the correct alphabetic position, replace "BARLEY" with "HEMP" in all lines, and then change all the parameters, so they correctly represent hemp. It is important that the name of the new fruit is spelled exactly as done on the map, and in capital letters. The fruit names displayed in the game is written for a nice

appearance. It is not written in the same way as used in the map code. A fruit may be displayed as “Red cabbage” while its code name is REDCABBAGE. Some fruits are defined multiple times due to different spellings in different maps.

If you fail, send an e-mail, and I’ll be glad to help. The e-mail is in the top of each script file.

Table 1. Crop input parameters.

```
RN.fruits.ALFALFA                = "ALFALFA";-- Lucerne
RN.cropDensity.ALFALFA           = 0.46;          -- kg/L
RN.cropYield.ALFALFA             = 198.12;        -- GEO EU 100 kg/ha
RN.yieldRange.ALFALFA            = 0.177          -- GEO EU
RN.seedDnsity.ALFALFA            = 0.737;         -- kg/L
RN.TSM.ALFALFA                   = 2;             -- 1000 seed mass
RN.plantsPerSqm.ALFALFA          = 360;           -- number of plants per sqm
RN.germination.ALFALFA           = 80;            -- Percentage of seeds that germinate
RN.seedUsagePerSqm.ALFALFA       = 0;             -- kg/sqm
RN.seedPricePer100kg.ALFALFA     = 46.00;         -- GEO DE, price / 100 kg
RN.cropPricePer100kg.ALFALFA     = 16.69;         -- GEO DE,  price / 100 kg
RN.seederCalibration.ALFALFA     = 1.000;         -- If seeder calibration is wanted.
RN.Nitrogen.ALFALFA              = 40;            -- kg/ha Nitrogen  (N) fertilizer per year
RN.Phosphate.ALFALFA             = 80 ;           -- kg/ha Phosphate (P) fertilizer per year
RN.Potassium.ALFALFA             = 120;           -- kg/ha Potassium (K) fertilizer per year
RN.growthDays.ALFALFA            = 60;            -- Real-life days from seeding to harvest

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 mass
RN.plantsPerSqm.ASPARAGUS        = 40;            -- number of plants per sqm
RN.germination.ASPARAGUS         = 90;            -- Percentage of seeds that germinate
RN.seedUsagePerSqm.ASPARAGUS     = 0;             -- kg/sqm, Only defined if TSM, PlantsPerSqm and
Germination are unknown
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.growthDays.ASPARAGUS          = 60;            -- Real-life days from seeding to harvest
```

3 Crop yield

The script **RealNumbersCropYield** sets the bulk material density and harvest yield of the in-game crops. For crop producing straw, the windrow yield is also set. A short excerpt is shown in Table 2.

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 2. Example of calculated grain crop output data printed to the log.

BARLEY massPerLiter	=	0.6180	kg/L
Yield randomness scaling	=	1.1586	
BARLEY base yield	=	0.5600	L/sqm
BARLEY base yield	=	5600	L/Ha
BARLEY no-plough loss	=	840	L/Ha
BARLEY no-weeding loss	=	1120	L/Ha
BARLEY liming gain	=	840	L/Ha
BARLEY 1x fertilizing gain	=	1400	L/Ha
BARLEY max yield	=	11200	L/Ha
BARLEY growth duration	=	3.6667	game days
BARLEY windrowLiterPerHa	=	40465	L/Ha
BARLEY round bales Per Ha	=	26.9764	Bales/Ha
BARLEY square bales Per Ha	=	15.5633	Bales/Ha
BARLEY seedMassPerLiter	=	0.6180	kg/L
BARLEY seedMassPerHa	=	93.3333	kg/Ha
BARLEY seedVolumePerHa	=	151.0248	L/Ha
BARLEY seedCostPerLiter	=	0.2966	€/L
BARLEY seedCostPerHa	=	44.8000	€/Ha
BARLEY pricePer1000Liter	=	95	€/1000 L
BARLEY pricePerHa	=	1066	€/Ha

Table 3. Example of calculated vegetable crop output data printed to the log.

CARROT massPerLiter	=	0.6410	kg/L
Yield randomness scaling	=	0.8118	
CARROT base yield	=	3.0614	L/sqm
CARROT base yield	=	30614	L/Ha
CARROT no-plough loss	=	4592	L/Ha
CARROT no-weeding loss	=	6123	L/Ha
CARROT liming gain	=	4592	L/Ha
CARROT 1x fertilizing gain	=	7653	L/Ha
CARROT max yield	=	61228	L/Ha
CARROT growth duration	=	2.5000	game days
CARROT seedMassPerLiter	=	0.4000	kg/L
CARROT seedMassPerHa	=	2.7625	kg/Ha
CARROT seedVolumePerHa	=	6.9063	L/Ha
CARROT seedCostPerLiter	=	0.1840	€/L
CARROT seedCostPerHa	=	1.2708	€/Ha
CARROT pricePer1000Liter	=	155	€/1000 L
CARROT pricePerHa	=	9498	€/Ha

Crop yield varies from year to year. For some crops it varies more than for others (Table 4). 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 4 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 4. 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

The yield randomness factor is set for each crop each time the game is started. It is therefore the value of this factor at harvest that determines the yield. If the field is large and the harvest is divided between different game sessions, the randomness factor will be different in each game session, resulting in different yield in each game session. While this behavior is a result of the way the script works, its effect is yield variation across a large field, a real-life fact. Random variation in yield can be turned off by setting the variable `randomness = 0`.

In the Help menu of FS19 it is explained that the crop yield depends on the condition of the field. The intended protocol for adjusting yield based on completed field work is shown in Table 5, center column. Say we want the maximum yield (all field work completed) to match a national/regional average yield of 10000 L/ha. According to the intended protocol, the game parameter should be set to `literPerSqm = 6060.6/10000 = 0.60606`. If you have ploughed and weeded, you should expect 6060.6 L/ha. If you have not ploughed nor weeded, then the yield should be 3939.5 L/ha. If you have completed all field work, you should expect 10000 L/ha. But instead you get two times the specified yield. This means that the actual protocol adds a bonus for ploughing and weeding to the specified "base" yield. Therefore, the script specifies the minimum yield as illustrated in the right most column in Table 5.

Table 5. Intended and actual protocol for yield bonus.

	Intended protocol	Actual protocol
Minimum yield	3939.5 L/ha	5000 L/ha
No ploughing (-15%)	-909.1 L/ha	+750 L/ha
No weeding (-20%)	-1212 L/ha	+1000 L/ha
Base yield	6060.6 L/ha	6750 L/ha
Lime application (+15%)	+909.1 L/ha	+750 L/ha
1x fertilizing (+25%)	+1515 L/ha	+1250 L/ha
1x fertilizing (+25%)	+1515 L/ha	+1250 L/ha
Maximum yield	10000 L/ha	10000 L/ha

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 ($8\ \mathrm{lb/ft^3}$). 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. Random fluctuation is included.

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. It is entered into the crop definition tables in the script RealNumbersInitialization as numbers of real-life days. The script converts the growth days to game days.

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 summary of crop yield, income and growth days can be printed by pressing lAlt-ry:

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

Table 6. Summary of crop yield. Press lAlt-ry. Grain dominated map.

ALFALFA max yield	=	50100	L/Ha
BARLEY max yield	=	10534	L/Ha
CANOLA max yield	=	4326	L/Ha
CARROT max yield	=	61228	L/Ha
COTTON max yield	=	366	L/Ha
DRYGRASS max yield	=	44571	L/Ha
GRASS max yield	=	36248	L/Ha
HOPS max yield	=	2650	L/Ha
MAIZE max yield	=	12524	L/Ha
MILLET max yield	=	3051	L/Ha
OAT max yield	=	13348	L/Ha
OILSEEDRADISH max yield	=	4638	L/Ha
ONION max yield	=	75102	L/Ha
POPLAR max yield	=	28200	L/Ha
POPPY max yield	=	11600	L/Ha
POTATO max yield	=	56517	L/Ha
RYE max yield	=	3060	L/Ha
SORGHUM max yield	=	5974	L/Ha
SOYBEAN max yield	=	4630	L/Ha
SPELT max yield	=	11754	L/Ha
SUGARBEET max yield	=	108495	L/Ha
SUGARCANE max yield	=	115743	L/Ha
SUNFLOWER max yield	=	5491	L/Ha
TOBACCO max yield	=	2191	L/Ha
TRITICALE max yield	=	6054	L/Ha
WEED max yield	=	0	L/Ha
WHEAT max yield	=	11634	L/Ha

Table 7. Summary of crop income per hectare. Grain dominated map.

ALFALFA max income	=	3846	€/Ha
BARLEY max income	=	1009	€/Ha
CANOLA max income	=	997	€/Ha
CARROT max income	=	9498	€/Ha
COTTON max income	=	36	€/Ha
DRYGRASS max income	=	939	€/Ha
GRASS max income	=	707	€/Ha
HOPS max income	=	12583	€/Ha
MAIZE max income	=	1526	€/Ha
MILLET max income	=	296	€/Ha
OAT max income	=	858	€/Ha
OILSEEDRADISH max income	=	0	€/Ha
ONION max income	=	8964	€/Ha
POPLAR max income	=	1128	€/Ha
POPPY max income	=	6960	€/Ha
POTATO max income	=	6952	€/Ha
RYE max income	=	327	€/Ha
SORGHUM max income	=	833	€/Ha
SOYBEAN max income	=	1274	€/Ha
SPELT max income	=	1451	€/Ha
SUGARBEET max income	=	2089	€/Ha
SUGARCANE max income	=	2536	€/Ha
SUNFLOWER max income	=	691	€/Ha
TOBACCO max income	=	3021	€/Ha
TRITICALE max income	=	718	€/Ha
WEED max income	=	0	€/Ha
WHEAT max income	=	1512	€/Ha

Table 8. Overview of crop real-life growth days converted to game days. Grain dominated map.

ALFALFA growth days	=	2.0000	game days
BARLEY growth days	=	3.6667	game days
CANOLA growth days	=	3.0000	game days
CARROT growth days	=	2.5000	game days
COTTON growth days	=	6.6667	game days
DRYGRASS growth days	=	2.0000	game days
GRASS growth days	=	2.0000	game days
HOPS growth days	=	4.0000	game days
MAIZE growth days	=	5.3333	game days
MILLET growth days	=	2.5000	game days
OAT growth days	=	3.6667	game days
OILSEEDRADISH growth days	=	1.5000	game days
ONION growth days	=	4.0000	game days
POPLAR growth days	=	12.0000	game days
POPPY growth days	=	2.0000	game days
POTATO growth days	=	4.0000	game days
RYE growth days	=	9.0000	game days
SORGHUM growth days	=	4.3333	game days
SOYBEAN growth days	=	4.6667	game days
SPELT growth days	=	4.5000	game days
SUGARBEET growth days	=	6.0000	game days
SUGARCANE growth days	=	5.3333	game days
SUNFLOWER growth days	=	4.3333	game days
TOBACCO growth days	=	3.0000	game days
TRITICALE growth days	=	5.3333	game days
WEED growth days	=	2.0000	game days
WHEAT growth days	=	9.0000	game days

Table 9. Summary of crop yield. Press lAlt-ry. Vegetable dominated US map.

BARLEY max yield	=	5899	L/Ha
CABBAGE max yield	=	102062	L/Ha
CANOLA max yield	=	2105	L/Ha
CARROT max yield	=	84986	L/Ha
CLOVER max yield	=	40435	L/Ha
COTTON max yield	=	6215	L/Ha
DRYGRASS max yield	=	26146	L/Ha
GRASS max yield	=	22803	L/Ha
HEMP max yield	=	3034	L/Ha
HOPS max yield	=	2329	L/Ha
LETTUCE max yield	=	101459	L/Ha
MAIZE max yield	=	12833	L/Ha
MILLET max yield	=	2417	L/Ha
OAT max yield	=	6631	L/Ha
OILSEEDRADISH max yield	=	2042	L/Ha
ONION max yield	=	91812	L/Ha
POPLAR max yield	=	28200	L/Ha
POPPY max yield	=	11600	L/Ha
POTATO max yield	=	54368	L/Ha
REDCABBAGE max yield	=	93885	L/Ha
RYE max yield	=	4473	L/Ha
SOYBEAN max yield	=	2550	L/Ha
SPELT max yield	=	9476	L/Ha
SUGARBEET max yield	=	49253	L/Ha
SUGARCANE max yield	=	115743	L/Ha
SUNFLOWER max yield	=	3711	L/Ha
TOBACCO max yield	=	3727	L/Ha
WEED max yield	=	0	L/Ha
WHEAT max yield	=	5898	L/Ha

Table 10. Summary of crop income per hectare. Vegetable dominated US map.

BARLEY max income	=	678	€/Ha
CABBAGE max income	=	17575	€/Ha
CANOLA max income	=	498	€/Ha
CARROT max income	=	14403	€/Ha
CLOVER max income	=	1860	€/Ha
COTTON max income	=	2297	€/Ha
DRYGRASS max income	=	551	€/Ha
GRASS max income	=	445	€/Ha
HEMP max income	=	3798	€/Ha
HOPS max income	=	21275	€/Ha
LETTUCE max income	=	22309	€/Ha
MAIZE max income	=	1333	€/Ha
MILLET max income	=	235	€/Ha
OAT max income	=	574	€/Ha
OILSEEDRADISH max income	=	0	€/Ha
ONION max income	=	24244	€/Ha
POPLAR max income	=	1128	€/Ha
POPPY max income	=	6960	€/Ha
POTATO max income	=	9782	€/Ha
REDCABBAGE max income	=	16167	€/Ha
RYE max income	=	807	€/Ha
SOYBEAN max income	=	707	€/Ha
SPELT max income	=	1254	€/Ha
SUGARBEET max income	=	902	€/Ha
SUGARCANE max income	=	2536	€/Ha
SUNFLOWER max income	=	680	€/Ha
TOBACCO max income	=	17164	€/Ha
WEED max income	=	0	€/Ha
WHEAT max income	=	768	€/Ha

Table 11. Overview of crop real-life growth days converted to game days. Vegetable dominated US map.

BARLEY growth days	=	3.3333	game days
CABBAGE growth days	=	3.0000	game days
CANOLA growth days	=	3.0000	game days
CARROT growth days	=	2.5000	game days
CLOVER growth days	=	2.0000	game days
COTTON growth days	=	5.2667	game days
DRYGRASS growth days	=	2.0000	game days
GRASS growth days	=	2.0000	game days
HEMP growth days	=	4.0000	game days
HOPS growth days	=	4.0000	game days
LETTUCE growth days	=	1.5000	game days
MAIZE growth days	=	5.3667	game days
MILLET growth days	=	2.5000	game days
OAT growth days	=	3.4333	game days
OILSEEDRADISH growth days	=	1.5000	game days
ONION growth days	=	4.0000	game days
POPLAR growth days	=	12.0000	game days
POPPY growth days	=	2.0000	game days
POTATO growth days	=	4.0000	game days
REDCABBAGE growth days	=	3.0000	game days
RYE growth days	=	9.3333	game days
SOYBEAN growth days	=	4.5000	game days
SPELT growth days	=	4.5000	game days
SUGARBEET growth days	=	6.0000	game days
SUGARCANE growth days	=	4.0000	game days
SUNFLOWER growth days	=	4.1667	game days
TOBACCO growth days	=	3.3333	game days
WEED growth days	=	2.0000	game days
WHEAT growth days	=	8.5000	game days

Notice that rye and wheat are here considered to be winter crops, i.e. they should be seeded in the fall and harvested mid-summer.

Figure 4. Harvesting cabbage.

The typical seeding and harvest dates for US Heartland has been collected in a Farmers calendar in Table 12. To follow such a calendar, one would use the first two game days on plowing the majority of starter-crops on the map, except fields with rye and wheat. Keeping these, you can pretend they were seeded in the previous fall as winter crop. Many crops are seeded on the fifth gameday. There is then time to grow a cover crop like oilseed radish and cultivate this into the soil as fertilizer before seeding.

Vegetable crops have been given a growth period of either 45, 60 or 90 days (1.5 – 3 game days). The growth period of grass is only 60 days (2 game days). If the player finds the growth days to be inaccurate or too long, it is easy to change the growth days with a standard text editor.

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 tractors, 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.

Table 12. Farmers calendar for US Heartland.

Start	End	Middle	Action	Game day
05-mar	01-apr	18-mar	Seed barley	3
15-mar	20-apr	02-apr	Seed oat	4
10-apr	30-apr	20-apr	Seed sugarbeet	4
20-apr	25-maj	07-maj	Seed maize	5
05-maj	20-maj	12-maj	Seed cotton	5
05-maj	20-maj	12-maj	Seed peanuts	5
01-maj	25-maj	13-maj	Seed rice	5
15-maj	30-maj	22-maj	Seed tobacco	5
15-maj	15-jun	30-maj	Seed sorghum	5
			1st hay cut	6
			Herbicide spraying	6
15-maj	01-jul	07-jun	Seed soybeans	6
25-jun	01-jul	28-jun	Harvest winter rye	6
20-jun	10-jul	30-jun	Harvest winter wheat	6
01-jul	25-jul	13-jul	Harvest oat	7
			Herbicide spraying	7
			2nd hay cut	8
25-aug	15-sep	04-sep	Harvest triticale	9
10-sep	20-sep	15-sep	Seed winter rye	9
25-sep	25-okt	10-okt	Harvest rice	10
20-sep	30-okt	10-okt	Harvest maize	10
25-sep	30-okt	12-okt	Harvest sorghum	10
05-okt	25-okt	15-okt	Harvest peanuts	10
05-okt	01-nov	18-okt	Harvest cotton	10
10-okt	30-okt	20-okt	Harvest soybeans	10
10-okt	30-okt	20-okt	Harvest sugarbeets	10
10-okt	01-nov	21-okt	Seed winter wheat	10

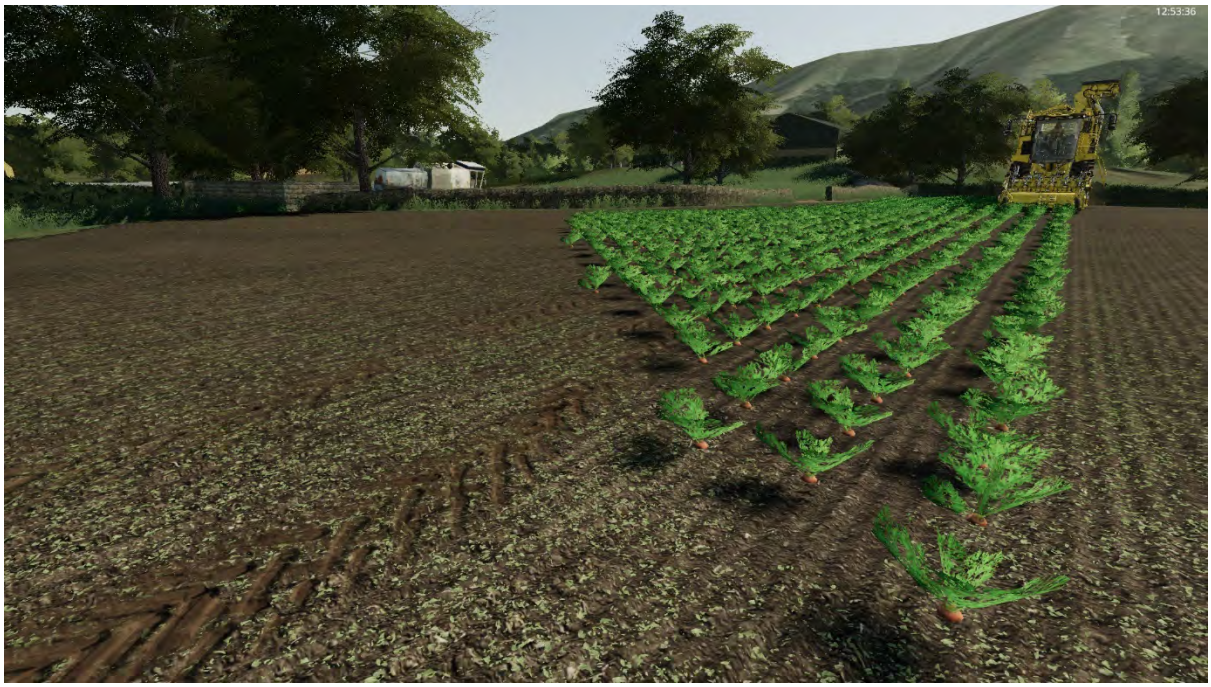

Figure 5. Harvesting carrots.

3.1 Weed management.

Weed has been assigned a growth period of 60 real-life days or 2 game days. The results of this has not been tested extensively. In one test, the growth days were set to 4 game days. In this case, the weed wave started rolling down from the north on game day 3. In another test, the weed growth days were set to 2 game days. In this case, the weed wave came on the second game day. Searching the internet for growth days for weeds returns very little information, except that weeds germinate and proliferate faster than regular crops. For this reason, I have set the weed growth days to 2. With this value, weed will appear in all crop fields. In most cases well before harvest.

A crop like lettuce has a short growth season of only 45 real-life days (1.5 game days). For such crops there is a risk, that weed will appear between the last growth stage and the first harvest stage. If this happens, there is nothing to do about it, except coming to terms with a reduced yield. For crops with a short growth season, herbicide should be sprayed before the weed wave rolls. This is a bit tricky, as there is no visual guidance when herbicide is sprayed at this time. And helpers will not take the job until there is visible weed in the field. My approach is to give the second fertilizer doze after seeding. This turns the field texture a bit darker. Following up with a round of herbicide is now easier, as the herbicide spray turns the field texture bright again. In this work order, you get a visual guidance to follow when spraying herbicide.

If a player wants to minimize the effects of weed it is worth trying to increase weed growth days to a large value. I have not tested this.

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 volume of round bales to 1500 L and that of square bales to 2600 L. This requires editing the possible bale volumes in the mod and the modsettings files using a text editor.

Table 13. Yield of grass per cut. Round bales = 1500 L, square bales = 2600 L..

GRASS massPerLiter	=	0.3900	kg/L
Yield randomness scaling	=	0.8526	
GRASS base yield	=	1.8124	L/sqm
GRASS base yield	=	18124	L/Ha
GRASS no-plough loss	=	2719	L/Ha
GRASS no-weeding loss	=	3625	L/Ha
GRASS liming gain	=	2719	L/Ha
GRASS 1x fertilizing gain	=	4531	L/Ha
GRASS max yield	=	36248	L/Ha
GRASS growth duration	=	2.0000	game days
GRASS windrowLiterPerHa	=	34436	L/Ha
GRASS round bales Per Ha	=	22.9570	Bales/Ha
GRASS square bales Per Ha	=	13.2444	Bales/Ha
GRASS seedMassPerLiter	=	0.6410	kg/L
GRASS seedMassPerHa	=	8.5556	kg/Ha
GRASS seedVolumePerHa	=	13.3472	L/Ha
GRASS seedCostPerLiter	=	2.2435	€/L
GRASS seedCostPerHa	=	29.9444	€/Ha
GRASS pricePer1000Liter	=	20	€/1000 L
GRASS pricePerHa	=	707	€/Ha

The density of grass and silage bales is set to $0.39\ kg/L$ and that of hay bales to $0.18\ kg/L$. 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 is set to produce about 26 round bales and about 15 square bales per hectare. Random fluctuation is included but can be turned off.

As of version 1.1.3, the volume of bales in the store are also 1500 L for round bales and 2600 L for square bales. For this reason, the store prices on round and square bales now differ.

Table 14. Yield of hay per cut. Round bales = 1500 L, square bales = 2600 L..

DRYGRASS massPerLiter	=	0.1800	kg/L
Yield randomness scaling	=	1.0481	
DRYGRASS base yield	=	2.2286	L/sqm
DRYGRASS base yield	=	22286	L/Ha
DRYGRASS no-plough loss	=	3343	L/Ha
DRYGRASS no-weeding loss	=	4457	L/Ha
DRYGRASS liming gain	=	3343	L/Ha
DRYGRASS 1x fertilizing gain	=	5571	L/Ha
DRYGRASS max yield	=	44571	L/Ha
DRYGRASS growth duration	=	2.0000	game days
DRYGRASS windrowLiterPerHa	=	42343	L/Ha
DRYGRASS round bales Per Ha	=	28.2286	Bales/Ha
DRYGRASS square bales Per Ha	=	16.2857	Bales/Ha
DRYGRASS seedMassPerLiter	=	0.6410	kg/L
DRYGRASS seedMassPerHa	=	8.5556	kg/Ha
DRYGRASS seedVolumePerHa	=	13.3472	L/Ha
DRYGRASS seedCostPerLiter	=	2.2435	€/L
DRYGRASS seedCostPerHa	=	29.9444	€/Ha
DRYGRASS pricePer1000Liter	=	21	€/1000 L
DRYGRASS pricePerHa	=	939	€/Ha

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:

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

The volume of seed per hectare is obtained by dividing the mass by the density of the seed. Example data is shown in Table 2 and Table 3.

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

Table 15. Germination percentage.

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

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 16. Predicted income per hectare for a multi fruit map assuming crop sell prices as in the UK.

BARLEY pricePerHa	=	1087	€/Ha
CABBAGE pricePerHa	=	17959	€/Ha
CANOLA pricePerHa	=	1084	€/Ha
CARROT pricePerHa	=	24528	€/Ha
LETTUCE pricePerHa	=	41808	€/Ha
MAIZE pricePerHa	=	1018	€/Ha
MILLET pricePerHa	=	246	€/Ha
OAT pricePerHa	=	769	€/Ha
ONION pricePerHa	=	16327	€/Ha
POTATO pricePerHa	=	7582	€/Ha
REDCABBAGE pricePerHa	=	17536	€/Ha
RYE pricePerHa	=	275	€/Ha
SORGHUM pricePerHa	=	994	€/Ha
SOYBEAN pricePerHa	=	477	€/Ha
SUGARBEET pricePerHa	=	2218	€/Ha
SUNFLOWER pricePerHa	=	829	€/Ha
WHEAT pricePerHa	=	1355	€/Ha

Table 17. Predicted income per hectare for a multi fruit map assuming crop sell prices as in Germany.

BARLEY pricePerHa	=	836	€/Ha
CABBAGE pricePerHa	=	14221	€/Ha
CANOLA pricePerHa	=	1104	€/Ha
CARROT pricePerHa	=	11612	€/Ha
HOPS pricePerHa	=	15644	€/Ha
MAIZE pricePerHa	=	1962	€/Ha
OAT pricePerHa	=	621	€/Ha
ONION pricePerHa	=	8673	€/Ha
POTATO pricePerHa	=	7106	€/Ha
REDCABBAGE pricePerHa	=	10407	€/Ha
RYE pricePerHa	=	622	€/Ha
SOYBEAN pricePerHa	=	1216	€/Ha
SPELT pricePerHa	=	1228	€/Ha
SUGARBEET pricePerHa	=	1932	€/Ha
SUNFLOWER pricePerHa	=	729	€/Ha
WHEAT pricePerHa	=	1466	€/Ha

Table 18. Predicted income per hectare for a multi fruit map assuming crop sell prices as in US Heartland.

BARLEY pricePerHa	=	554	€/Ha
CANOLA pricePerHa	=	520	€/Ha
MAIZE pricePerHa	=	1145	€/Ha
OAT pricePerHa	=	402	€/Ha
POTATO pricePerHa	=	9895	€/Ha
SOYBEAN pricePerHa	=	656	€/Ha
SUGARBEET pricePerHa	=	993	€/Ha
SUNFLOWER pricePerHa	=	661	€/Ha
WHEAT pricePerHa	=	871	€/Ha

Table 16, Table 17, and Table 18 illustrate the difference in crop income per hectare between UK, Germany and US Heartland. The sell prices of vegetable crops are remarkably high in the UK. Unfortunately, I'm not aware of any UK map with the multifruit feature.

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. You need to harvest 203 hectares of sugarbeet, before the 495,000 € Holmer Sugarbeet harvester is paid off. If you only have 2 hectares of sugarbeet, that would take 100 years. The table also suggest that growing Oat and Sunflower is a waste of good land, unless you have a couple of horses to feed. In other countries/USDA regions the picture is likely to be completely different. On multifruit maps, vegetables give considerably higher income per hectare than grain crops.

Figure 7. Real-life crop sell-prices. The prices shown here are scaled by a factor 2 compared to Table 16 because the economic difficulty level was set to Normal at the time when the screen dump was made.

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.

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, 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 8. 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 19.

Table 19. Nutrient content removed from the field at harvest.

BARLEY	N = 174.0 kg/ha,	P2O5 = 74.0 kg/ha,	K2O = 176.0 kg/ha
CABBAGE	N = 90.0 kg/ha,	P2O5 = 90.0 kg/ha,	K2O = 90.0 kg/ha
CANOLA	N = 134.0 kg/ha,	P2O5 = 49.0 kg/ha,	K2O = 41.0 kg/ha
CARROT	N = 240.0 kg/ha,	P2O5 = 82.0 kg/ha,	K2O = 143.0 kg/ha
CLOVER	N = 27.0 kg/ha,	P2O5 = 9.0 kg/ha,	K2O = 44.0 kg/ha
COTTON	N = 15.0 kg/ha,	P2O5 = 4.3 kg/ha,	K2O = 2.7 kg/ha
DRYGRASS	N = 0.0 kg/ha,	P2O5 = 0.0 kg/ha,	K2O = 0.0 kg/ha
GRASS	N = 27.0 kg/ha,	P2O5 = 9.0 kg/ha,	K2O = 44.0 kg/ha
LETTUCE	N = 140.0 kg/ha,	P2O5 = 45.0 kg/ha,	K2O = 230.0 kg/ha
MAIZE	N = 140.0 kg/ha,	P2O5 = 61.0 kg/ha,	K2O = 36.0 kg/ha
MILLET	N = 35.0 kg/ha,	P2O5 = 50.0 kg/ha,	K2O = 25.0 kg/ha
OAT	N = 118.0 kg/ha,	P2O5 = 45.0 kg/ha,	K2O = 149.0 kg/ha
OILSEEDRADISH	N = 0.0 kg/ha,	P2O5 = 0.0 kg/ha,	K2O = 0.0 kg/ha
ONION	N = 180.0 kg/ha,	P2O5 = 100.0 kg/ha,	K2O = 170.0 kg/ha
POPLAR	N = 225.0 kg/ha,	P2O5 = 75.0 kg/ha,	K2O = 75.0 kg/ha
POTATO	N = 166.0 kg/ha,	P2O5 = 58.0 kg/ha,	K2O = 250.0 kg/ha
REDCABBAGE	N = 90.0 kg/ha,	P2O5 = 90.0 kg/ha,	K2O = 90.0 kg/ha
RICE	N = 450.0 kg/ha,	P2O5 = 180.0 kg/ha,	K2O = 100.0 kg/ha
RYE	N = 30.0 kg/ha,	P2O5 = 82.0 kg/ha,	K2O = 143.0 kg/ha
SORGHUM	N = 120.0 kg/ha,	P2O5 = 50.0 kg/ha,	K2O = 25.0 kg/ha
SOYBEAN	N = 175.0 kg/ha,	P2O5 = 41.0 kg/ha,	K2O = 50.0 kg/ha
SUGARBEET	N = 166.0 kg/ha,	P2O5 = 79.0 kg/ha,	K2O = 294.0 kg/ha
SUGARCANE	N = 136.0 kg/ha,	P2O5 = 50.0 kg/ha,	K2O = 100.0 kg/ha
SUNFLOWER	N = 60.0 kg/ha,	P2O5 = 29.0 kg/ha,	K2O = 18.0 kg/ha
WEED	N = 0.0 kg/ha,	P2O5 = 0.0 kg/ha,	K2O = 0.0 kg/ha
WHEAT	N = 240.0 kg/ha,	P2O5 = 82.0 kg/ha,	K2O = 143.0 kg/ha
WHEAT STRAW	N = 50.8 kg/ha,	P2O5 = 11.6 kg/ha,	K2O = 113.0 kg/ha
BARLEY STRAW	N = 49.0 kg/ha,	P2O5 = 15.6 kg/ha,	K2O = 154.9 kg/ha
OAT STRAW	N = 31.1 kg/ha,	P2O5 = 8.6 kg/ha,	K2O = 127.4 kg/ha
Mean values	N = 127.3 kg/ha,	P2O5 = 56.5 kg/ha,	K2O = 109.0 kg/ha

7.2 Nutrient content in fertilizer materials.

The script assumes that the amount of nutrients spread is divided between organic and nonorganic sources of fertilizers. The script assumes that 30 % is supplied via organic fertilizers (slurry, manure or digestate) and that the rest is supplied by artificial fertilizers.

Table 20. Nutrient content in organic and artificial fertilizers. (crop av. = crop available)

FERTILIZER	N = 140.0 kg/Tonne,	P2O5 = 70.0 kg/Tonne,	K2O = 140.0 kg/Tonne
FERTILIZER crop av.	N = 112.0 kg/Tonne,	P2O5 = 56.0 kg/Tonne,	K2O = 126.0 kg/Tonne
LIQUIDFERTILIZER	N = 300.0 kg/Tonne,	P2O5 = 80.0 kg/Tonne,	K2O = 100.0 kg/Tonne
LIQUIDFERTILIZER crop av.	N = 285.0 kg/Tonne,	P2O5 = 76.0 kg/Tonne,	K2O = 95.0 kg/Tonne
pigLIQUIDMANURE	N = 3.6 kg/Tonne,	P2O5 = 1.5 kg/Tonne,	K2O = 2.2 kg/Tonne
pigLIQUIDMANURE crop av.	N = 2.0 kg/Tonne,	P2O5 = 0.8 kg/Tonne,	K2O = 2.0 kg/Tonne
cowLIQUIDMANURE	N = 2.6 kg/Tonne,	P2O5 = 1.2 kg/Tonne,	K2O = 2.5 kg/Tonne
cowLIQUIDMANURE crop av.	N = 1.0 kg/Tonne,	P2O5 = 0.7 kg/Tonne,	K2O = 2.3 kg/Tonne
pigMANURE	N = 7.0 kg/Tonne,	P2O5 = 6.0 kg/Tonne,	K2O = 8.0 kg/Tonne
pigMANURE crop av.	N = 1.1 kg/Tonne,	P2O5 = 3.6 kg/Tonne,	K2O = 7.2 kg/Tonne
cowMANURE	N = 6.0 kg/Tonne,	P2O5 = 3.2 kg/Tonne,	K2O = 9.4 kg/Tonne
cowMANURE crop av.	N = 0.6 kg/Tonne,	P2O5 = 1.9 kg/Tonne,	K2O = 8.5 kg/Tonne
DIGESTATE	N = 4.9 kg/Tonne,	P2O5 = 1.1 kg/Tonne,	K2O = 3.5 kg/Tonne
DIGESTATE crop av.	N = 2.7 kg/Tonne,	P2O5 = 0.7 kg/Tonne,	K2O = 3.1 kg/Tonne
COMPOST	N = 9.0 kg/Tonne,	P2O5 = 5.5 kg/Tonne,	K2O = 6.5 kg/Tonne
COMPOST crop av.	N = 5.0 kg/Tonne,	P2O5 = 3.3 kg/Tonne,	K2O = 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 20). 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 advantage of artificial fertilizers, as they contain many times more nutrient per mass of fertilizer than organic sources.

7.3 Amounts of organic and inorganic 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 21 compares the spray rate for different fertilizer types and for a few crops.

Table 21. 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	1.09	0.21	49.71	87.00	26.36	50.19	19.37	10.55
BARLEY	: P: T/ha	0.92	0.34	6.17	11.56	29.60	30.83	33.64	6.73
BARLEY	: K: T/ha	0.98	0.65	7.33	6.24	26.67	23.47	16.76	9.03
BARLEY	: W: T/ha	0.95	0.36	10.64	18.57	28.98	32.03	30.52	7.34
BARLEY	: W: 1000 L/ha	1.18	0.28	17.73	30.96	32.20	35.59	33.91	12.23
BARLEY	: €/ha	592	224	85	149	212	234	110	363

		Fert	LiFe	PiMa	CoMa	PiLi	CoLi	Dige	Comp
CABBAGE	: N: T/ha	0.56	0.11	25.71	45.00	13.64	25.96	10.02	5.45
CABBAGE	: P: T/ha	1.12	0.41	7.50	14.06	36.00	37.50	40.91	8.18
CABBAGE	: K: T/ha	0.50	0.33	3.75	3.19	13.64	12.00	8.57	4.62
CABBAGE	: W: T/ha	1.01	0.38	8.95	16.07	31.53	33.80	34.59	7.55
CABBAGE	: W: 1000 L/ha	1.26	0.29	14.91	26.78	35.03	37.55	38.43	12.59
CABBAGE	: €/ha	629	235	72	129	230	247	125	373

		Fert	LiFe	PiMa	CoMa	PiLi	CoLi	Dige	Comp
CANOLA	: N: T/ha	0.84	0.16	38.29	67.00	20.30	38.65	14.92	8.12
CANOLA	: P: T/ha	0.61	0.23	4.08	7.66	19.60	20.42	22.27	4.45
CANOLA	: K: T/ha	0.23	0.15	1.71	1.45	6.21	5.47	3.90	2.10
CANOLA	: W: T/ha	0.60	0.21	7.27	12.97	18.33	20.75	19.70	4.59
CANOLA	: W: 1000 L/ha	0.75	0.16	12.11	21.62	20.37	23.05	21.89	7.64
CANOLA	: €/ha	373	133	58	104	134	151	71	227

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

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 22. 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 22 shows that the spray rate for liquid fertilizer range from 138 to 1100 Liters/ha.

Table 23. 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 23 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 of the mod, `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 $31\ m^3/ha$, while for pig manure it should be set to $18\ m^3/ha$. 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:

```
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.

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

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

Table 24. Summary of spray rates. Press lAlt-rs.

		Fert	LiFe	PiMa	CoMa	PiLi	CoLi	Dige	Comp
BARLEY	: W: 1000 L/ha	1.18	0.28	17.73	30.96	32.20	35.59	33.91	12.23
CABBAGE	: W: 1000 L/ha	1.26	0.29	14.91	26.78	35.03	37.55	38.43	12.59
CANOLA	: W: 1000 L/ha	0.75	0.16	12.11	21.62	20.37	23.05	21.89	7.64
CARROT	: W: 1000 L/ha	1.31	0.30	21.53	37.93	35.60	40.18	37.61	13.59
CLOVER	: W: 1000 L/ha	0.16	0.04	2.59	4.39	4.40	4.85	4.44	1.74
COTTON	: W: 1000 L/ha	0.59	0.13	8.53	15.24	16.24	17.97	17.57	6.00
DRYGRASS	: W: 1000 L/ha	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GRASS	: W: 1000 L/ha	0.16	0.04	2.59	4.39	4.40	4.85	4.44	1.74
HEMP	: W: 1000 L/ha	1.08	0.24	14.92	26.75	29.92	32.86	32.58	10.94
HOPS	: W: 1000 L/ha	0.44	0.10	10.06	17.26	11.32	13.70	10.99	4.79
LETTUCE	: W: 1000 L/ha	0.83	0.21	13.26	22.40	22.23	24.56	22.35	8.83
MAIZE	: W: 1000 L/ha	0.90	0.20	13.69	24.59	24.65	27.61	26.76	9.12
MILLET	: W: 1000 L/ha	0.67	0.15	7.40	13.48	18.79	20.01	20.90	6.63
OAT	: W: 1000 L/ha	0.76	0.18	11.65	20.09	20.49	22.66	21.22	7.92
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	1.51	0.35	20.86	36.84	41.45	45.32	44.43	15.39
POPLAR	: W: 1000 L/ha	1.17	0.26	19.57	34.82	31.72	36.10	33.88	12.00
POPPY	: W: 1000 L/ha	1.03	0.24	11.24	20.23	28.77	30.49	31.72	10.24
POTATO	: W: 1000 L/ha	1.03	0.25	16.09	27.39	27.63	30.51	28.13	10.84
REDCABBAGE	: W: 1000 L/ha	1.26	0.29	14.91	26.78	35.03	37.55	38.43	12.59
RYE	: W: 1000 L/ha	1.15	0.28	11.53	20.43	32.07	33.45	35.02	11.46
SOYBEAN	: W: 1000 L/ha	0.68	0.15	13.24	23.42	18.37	21.53	19.26	7.16
SPELT	: W: 1000 L/ha	1.31	0.30	21.53	37.93	35.60	40.18	37.61	13.59
SUGARBEET	: W: 1000 L/ha	1.32	0.32	18.72	32.03	35.83	38.94	37.08	13.77
SUGARCANE	: W: 1000 L/ha	0.80	0.18	12.73	22.34	21.75	24.36	22.94	8.29
SUNFLOWER	: W: 1000 L/ha	0.42	0.09	6.20	11.15	11.62	12.93	12.65	4.28
TOBACCO	: W: 1000 L/ha	1.16	0.28	14.15	24.43	31.89	33.92	33.74	11.88
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	1.31	0.30	21.53	37.93	35.60	40.18	37.61	13.59

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.

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.

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 26 and Table 27. 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 25. 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

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.

Table 26. 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 27. 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.annualLoanInterest  =       4;                    -- Annual interest rate on loans
RN.loanMax             = 3000000;                    -- Max loan
RN.pricePerHa          =   25000;                    -- purchase price of farmland per hectare
RN.rentPricePerHa      = 0.025 * RN.pricePerHa;      -- rent price of farmland per hectare
RN.rentedFields        =  { 5, 9, 14, 16, 20, 23, 28, 32, 38, 43, 49, 56, 60, 67, 73, 84};
```

The list of rentable farmlands can be changed. I have randomly chosen 2 out of 10 farmlands to be rentable. The list can be extended or shortened as needed. 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 are rentable.

The purchase price of a number of commodities are listed in Table 28. Herbicide and fertilizers are expensive. For herbicide and liquid fertilizer, 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 28. 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
DEF fillTypeIndex	=	33	
DEF massPerLiter	=	0.5000	kg/L
RandomPriceFactor	=	0.9737	
DEF price	=	1217	€/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.

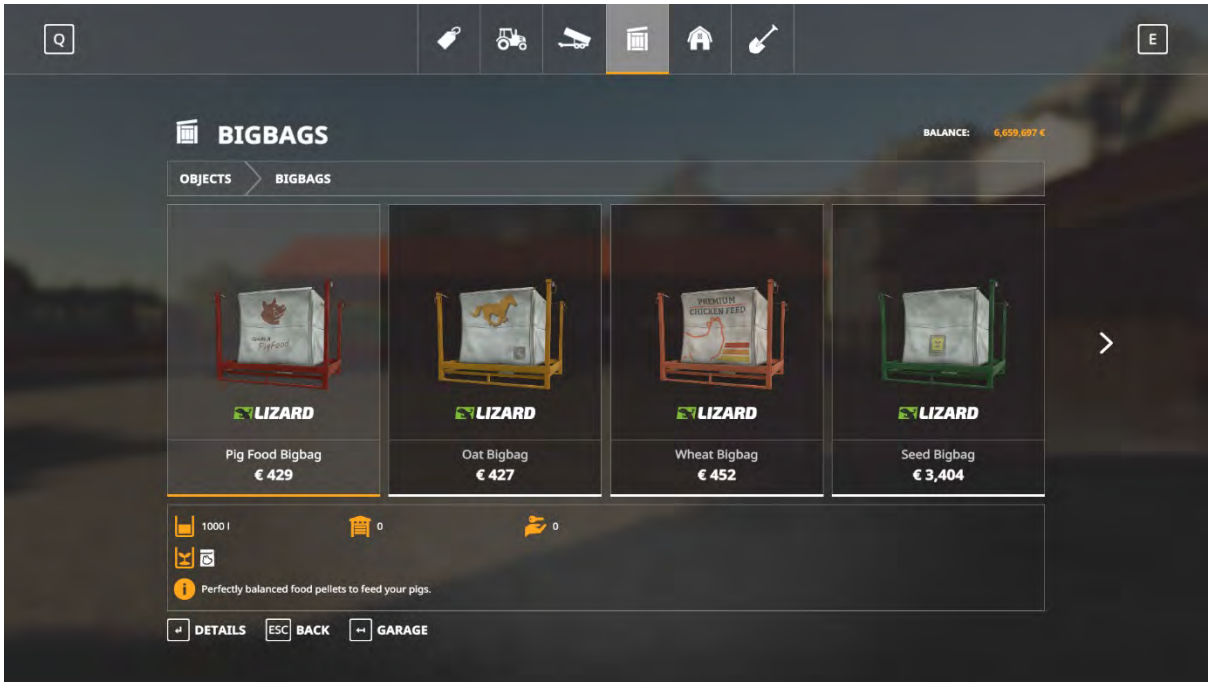

Figure 9. Modified store prices on pallets.

Figure 10. Not everything costs money. Sometimes you are lucky. Oberlausitz map by RitchiF.

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 16, the crop income will be about 10,000 €. 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 €.

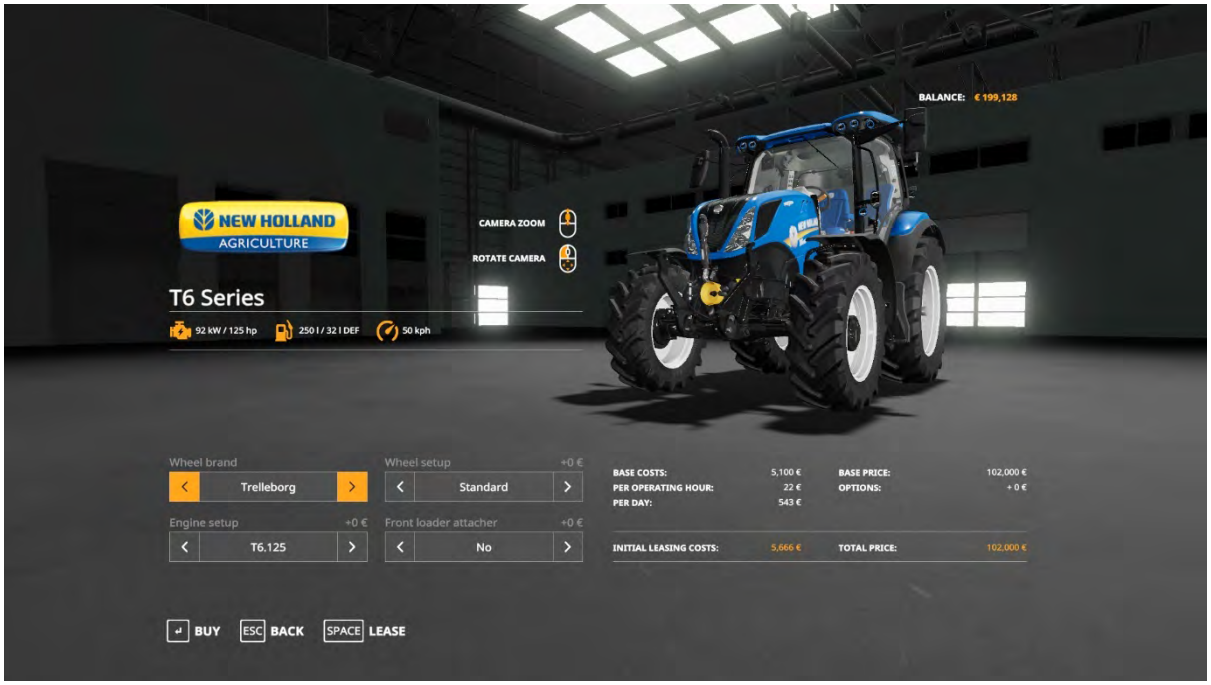

Figure 11. Reduced leasing cost on tractor.

The script **RealNumbersLeasing.lua** presents the mod user with the option of designing their own leasing contracts (see Figure 11 and Table 29).

Table 29. Equipment leasing contract.

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. Consequently, the mod user who wants to lease equipment on a day-by-day basis will have to reduce the “Initial Installment factor”.

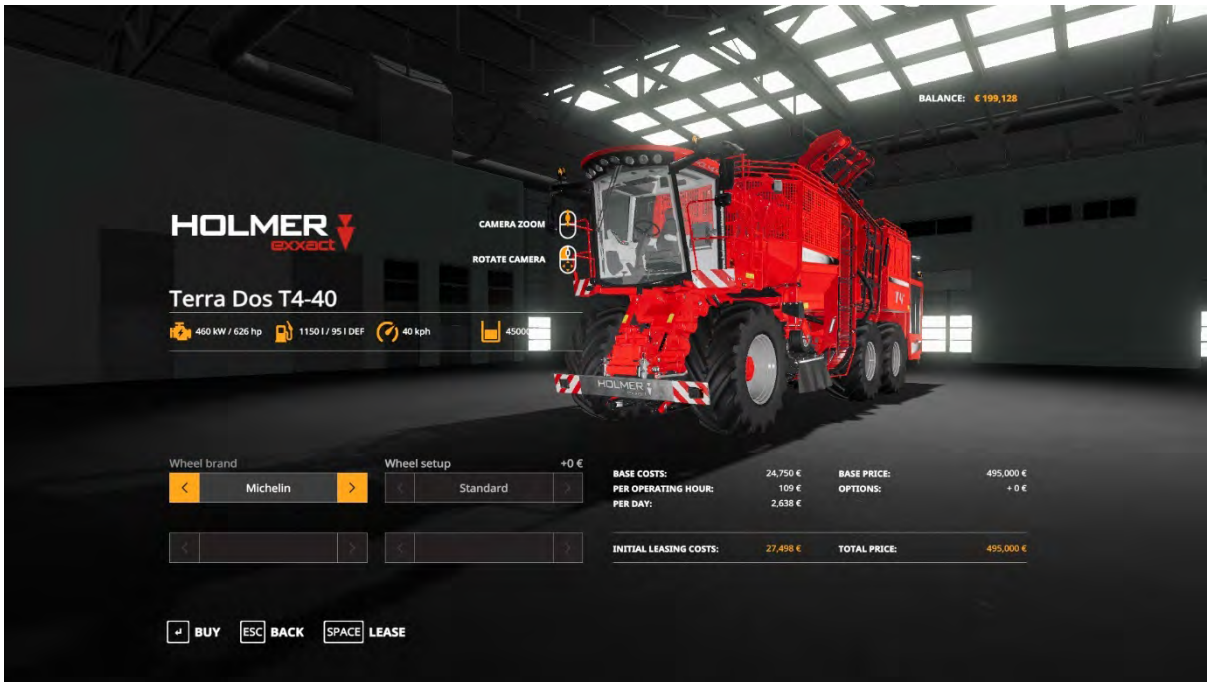

Figure 12. Reduced lease on sugar beet harvester.

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

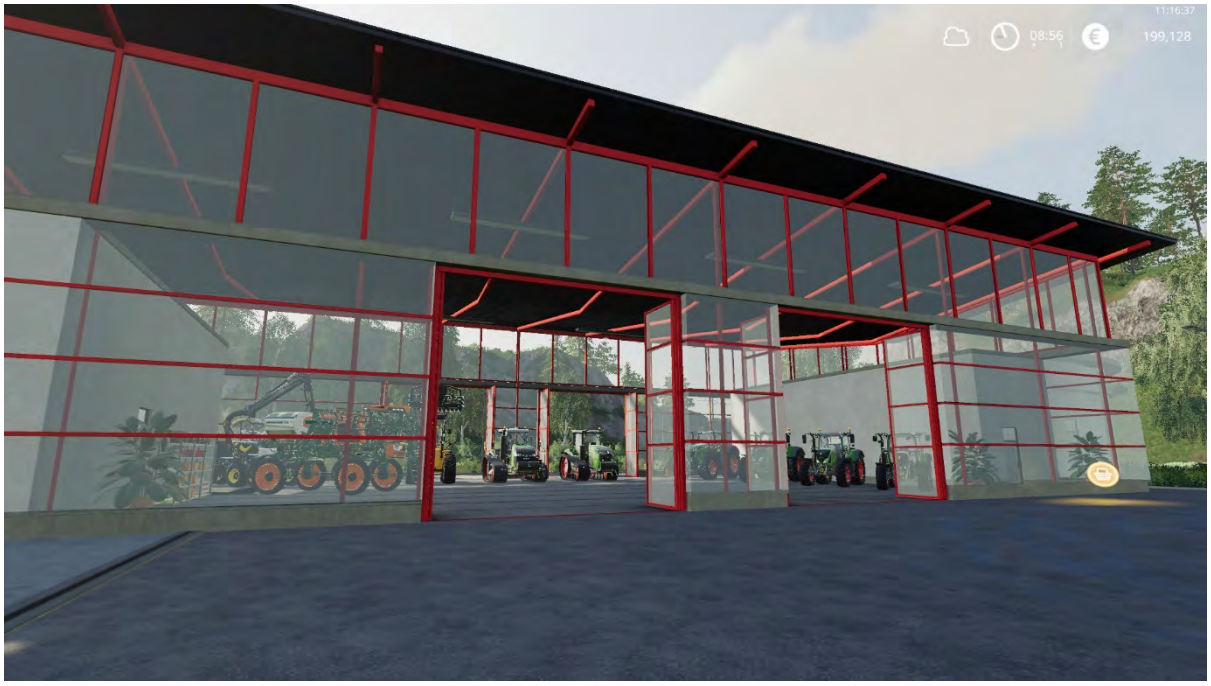

Figure 14. Not a cardboard dealer. Felsbrunn.

The objective of RealNumbersLeasing is to make leasing a viable alternative to buying. As one-day leasing and six-year leasing obviously are very different things, the mod user will have to design the lease contract parameters to fit the leasing conditions that fit his/her game style.

As mentioned earlier, short-term 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.

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.

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 bulk volume of 50 ml/egg, yielding 1.2 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	=	2531	€/1000 L
EGG massPerLiter	=	1.2000	kg/L
EGG pricePer1000Liter	=	1908	€/1000 L

Figure 15. Off to the spinnery. Felsbrunn.

11 Animal care

The script **RealNumbersAnimalCare** redefines a large number of parameters associated with husbandry farming. These parameters can be divided into three main groups:

- Reproduction rate
- Animal input (food consumption)
- Animal output

In addition, the script makes predictions on:

- Total amount of feed required per animal type for one year
- Amount of bedding straw bales required per animal type for one year
- Amount of water consumed in a year
- Amount of feed components required (grain, protein, root crop, grass, hay, silage)
- Number of bales (straw, hay, and silage) needed for feed
- Field areas required to produce the feed and bales
- Amount of milk, manure and slurry produced in a year.

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

These predictions are made for small pens and for large-scale specialized pens. The predictions can help the mod user to determine, how many animals can be fed by a certain amount of farmland. If

you want to aim for an average farm hold in a specific EU country, Table 31 lists the average number of farm animals.

11.1 Animal reproduction rate

Farming Simulator uses the same type of reproduction model for all animal types. This model ignores that pigs typically gets 13-14 pigs in a litter and sheep produce on average 1.25 lambs (can be set by the user). The in-game model also ignores that it takes a considerable time before an animal is mature enough to reproduce. We cannot side-step the in-game model used, but we can set up birth rates such that we will see a realistic increase in the number of animals within a breeding cycle. Examples of small-scale pens are shown in Table 32. The number of breeders can easily be changed.

Table 32. Breeding model parameters

Parameter	Symbol	Pig	Cows	Sheep	Chicken
Game days per year		12	12	12	12
Breeding cycles per year		2	1	1	4
Breeding days	N_{days}	6	12	12	3
Litter size per breeder		13	1	1.25	7
Number of breeders	n_0	6	20	30	10
Offspring		78	20	37.5	70
Animals after one cycle	n_{end}	84	40	67.5	80
Pen capacity	n_{max}	100	50	80	100
Birth rate parameter	k	0.7350	0.1493	0.1831	1.1945
Mean number of animals	n_{mean}	40.15	30.66	50.47	41.97
Time to first birth		5:22:58	13:17:29	6:56:45	2:08:22

Figure 16. Two pig pens, 2 cow pens, 3 sheep pens, 1 chicken pen and 1 horse pen on Felsbrunn.

For this scheme to work, we must operate with the concept of a year, and number of game days per year. Without the Seasons mod by Realismus Modding, this is all completely fictional, and only serves the purpose of generating real-life animal reproduction.

Target numbers for animal reproduction is listed in Table 32. Horses do not breed in FS19. It requires a bit of mathematics to calculate the birth rates that will produce the target numbers. If not interested, skip this part.

$$\frac{dn}{dt} = k\frac{n_{max} - n(t)}{n_{max}} \times n(t)$$

The rate of increase in animal numbers (dn/dt) is proportional to the current number of animals ($k \times n(t)$), and k is the birth rate parameter we want to determine. As a new feature in FS19, birthrate will decrease as the number of animals in the pen approaches the pen capacity (n_{max}). As $n(t) \to n_{max}$, the fraction on the right-hand side approaches zero. To avoid severe effects of this growth stagnation, pen capacity should be much larger than the number of animals intended to hold.

The solution to the differential equation is:

$$n(t) = \frac{e^{k\,t}\, n_0\, n_{max}}{n_{max} + n_0(e^{k\,t} - 1)}$$

where n_0 is the starting number of animals. Solving for the birth rate k, we get:

$$k = \frac{1}{t}\ln\left(\frac{n(t)}{n_0} \times \frac{n_{max} - n_0}{n_{max} - n(t)}\right)$$

To make this result useful, we will define time t as the number of game days in the breeding cycle (N_{days}). The target number of animals we will denote n_{end}. Inserting this notation, we get:

$$k = \frac{1}{N_{days}}\ln\left(\frac{n_{end}}{n_0} \times \frac{n_{max} - n_0}{n_{max} - n_{end}}\right)$$

Using this equation, the birth rate has been calculated for the parameters listed in Table 32. For calculating feed consumption, we also need to know the average number of animals within the breeding cycle:

$$n_{mean} = \frac{n_{max}}{k\, N_{days}}\ln\left(1 - \frac{n_0}{n_{max}}\left(1 - e^{k\,N_{days}}\right)\right)$$

The script also calculates the time to the first birth.

Figure 17 shows the growth in the number of animals over time (months). For pigs and chickens, the growth-limiting effect of the pen capacity causes the growth rate to approach stagnation. For sheep and cows, the pen capacity is not limiting.

To make it clear whether a potential capacity limitation can slow down animal production by an unforeseen amount, the script prints out the pen capacities found on the map.

If the preset number of birth-giving animals is too big for the pen capacity, the number of birth-giving animals are reduced sufficiently for the pen to hold all animals at the end of the rearing cycle.

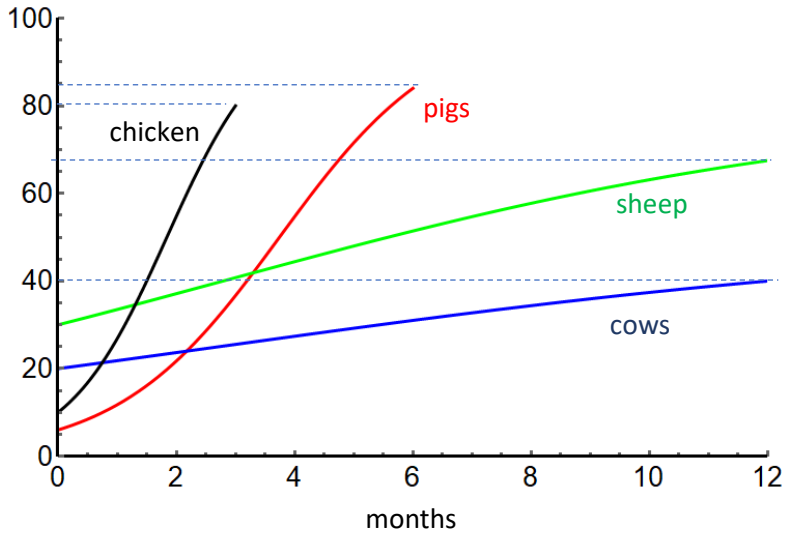

Figure 17. Growth rate of animals.

Table 33. Animal pen capacities on the map.

Pig shed number 1 has a capacity of	=	300	animals
Pig shed number 2 has a capacity of	=	500	animals
Cow shed number 1 has a capacity of	=	200	animals
Cow shed number 2 has a capacity of	=	500	animals
Sheep shed number 1 has a capacity of	=	80	animals
Sheep shed number 2 has a capacity of	=	250	animals
Sheep shed number 3 has a capacity of	=	250	animals
Chicken shed number 1 has a capacity of	=	100	animals
Horse shed number 1 has a capacity of	=	16	animals

To allow the user to follow the progress in animal reproduction, Table 34 shows the development in number of animals, game day by game day for different size pens. If you filled the pen with the starting animals at 11:00, then your daily check up on progress should be at 11:00.

Notice that the numbers listed in Table 34 depend on the pen size. If your pen size is different, the numbers will not agree. Notice that the birthrate (k) is sometimes identical. This happens, if one pen is a complete upscale of another.

We don’t know for sure, if the proposed approach to determine the birth rate actually agrees with Farming Simulator. To investigate this, a test run was made with 6 sows in a pen with capacity for 300 pigs. The “Time to next animal” was recorded for the first six births and entered into Table 35 together with times predicted by RealNumbersAnimalCare.

Figure 18. Thirsty pigs. Oberlausitz map by RitchiF.

Table 34. Evolution in animal numbers as game days progress.

	Pigs	Pigs	Pigs	Cows	Cows	Cows	Sheep	Sheep	Sheep
Start number	6	12	24	20	40	100	30	100	200
Litter size	13	13	13	1	1	1	1.25	1.25	1.25
End number	84	168	336	40	80	200	67.5	225	450
Pen size	100	300	500	50	200	500	80	250	500
Grow days	6	6	6	12	12	12	12	12	12
k	0.7350	0.5699	0.6174	0.1493	0.0817	0.0817	0.1831	0.2169	0.2169
Game day									
1	11.7	20.6	42.7	21.8	42.7	106.7	33.5	113.2	226.5
2	21.7	34.6	73.9	23.7	45.5	113.7	37.1	126.8	253.5
3	36.7	56.2	121.6	25.5	48.4	121.1	40.8	140.2	280.5
4	54.7	86.8	186.7	27.4	51.5	128.7	44.4	153.4	306.8
5	71.6	125.6	262.5	29.2	54.7	136.7	48.0	165.9	331.8
6	84.0	168.0	336.0	31.0	58.0	144.9	51.4	177.5	355.1
7				32.7	61.4	153.5	54.7	188.2	376.3
8				34.4	64.9	162.3	57.8	197.7	395.4
9				35.9	68.6	171.4	60.6	206.1	412.2
10				37.4	72.3	180.7	63.1	213.4	426.8
11				38.8	76.1	190.3	65.4	219.7	439.4
12				40.0	80.0	200.0	67.5	225.0	450.0

The numbers are the minutes between consecutive births. The RN column is predicted times and FS19 are observed times. It is noted, that FS19 rounds off “Time to next animal” to the nearest quarter. Over a long season, such rounding can lead to a significant deviation between expected and actual animals at the end of the rearing season.

Table 35. Comparison of predicted "Time to next animal" with that observed in FS19.

	Pigs	
Start number	6	
Litter size	13	
End number	84	
Pen size	300	
Grow days	6	
k	0.4912	
	Minutes to next animal	
	RN	FS19
1	498.54	495
2	428.78	420
3	376.47	375
4	335.79	330
5	303.25	300
6	276.64	270

11.2 Small scale versus large scale husbandry

Farming Simulator 19 has introduced animal subtypes. There are 4 types of pigs, sheep, and chickens and 8 types of cows and horses. Each animal subtype can be assigned different parameters for feed consumption, reproduction, and production of milk, wool and egg. This allows the mod to set up specialized pen types for each animal and use the animal subtypes to define different features of each pen. This is only the second-best option. It would have been better if the features of the animals were inherited from the pen they are living in, so you could define breeding pen, grower's pen, finisher's pen, etc. As this is not the case, the approach taken is to use the subtypes of animals to define breeders, growers, finishers etc.

Table 36. Standard animal pens.

	Pigs	Cows	Sheep	Chicken
Animal color	Red	Brown	White	Black
Animal color		Brahman Brown		
Mature	6	20	24	42
Littersize	13	1	1.25	7
Offspring per breeding cycle	78	20	30	294
Breeding cycle (months)	6	12	12	12

The mod offers standard pens and specialized pens. The standard pens operate as we are used to. Standard pen animals breed and produce milk, egg or wool. Offspring becomes immediately mature and start breeding themselves. As far as the standard pens are concerned, the mod only adjusts the feed consumption, birthrates and production rates so to compensate for the fact that offspring do not eat as much as mature animals, and they do not breed, or produce milk, egg or wool. After a set time, the pen has produced a realistic number of offspring, produced realistic amounts of milk, egg, and wool and consumed a realistic amount of feed, water and bedding straw (Table 36). Standard pens are best suited for small scale animal farming.

11.3 Large-scale pig farming

In this mod, large-scale pig farming requires three specialized pens to be used (Table 37).

Table 37. Large-scale pig farming

	Breeder's pen	Grower's pen	Finisher's pen
Animal color	White	Black-White	Black
Breeding cycle (months)	6	6	6
Offspring months in pen	2	1	1
Mature animals (breeding)	48	0	0
Litters per month	8	0	0
Offspring (non-breeding) per month	104	0	0
Added offspring per month	0	104	104
Removed offspring per month	104	104	104
Starting weight (kg)	1	21	47
End weight (kg)	21	47	81

Figure 19. Large-scale pig farming at Fenton Forest by Stevie.

With two litters per year, 48 sows will have 96 litters. Spread out evenly, this corresponds to 8 litters of 13 piglets per month. Each litter of piglets stays in the breeder's pen for 2 months, but each month 8 litters are moved to the grower's pen. The growers only stay in the grower's pen for one month, then 104 growers are "moved" to the finisher's pen. The finishers stay in the finisher's pen for one month and are then sold for slaughter. Hence 104 finishers are sold for slaughter each month. You can change the number of pigs as you desire.

Because the features of the growers are defined by the animal color and not by the pen, we cannot actually move the growers from the grower's pen to the finisher's pen. Instead we must sell the black-white growers at the grower's pen and buy the black finishers at the finisher's pen. The

growers are sold at the same price as the finishers are bought, hence the “move” is economically neutral. For this reason, the transport fee is set to zero for animals in specialized pens.

The reason we cannot mix growers and finishers in the same pen is that their feed consumption and waste production differ.

11.4 Large-scale dairy farming.

For large-scale dairy farming there are three specialized pens.

Table 38. Large-scale dairy farming.

	Milker’s pen	1st year pen	2nd year pen
Animal color	White	Black	Black-White
Animal color (Brahman)	White	Light brown	Grey
Breeding cycle (months)	12	12	12
Offspring months in pen	0	12	12
Mature animals (breeding)	96	1	0
Offspring (non-breeding) per year	0	96	0
Added offspring per year	0	96	16
Removed offspring per month	0	96	16
Starting weight (kg)	0	20	290
End weight (kg)	0	290	545

Newborn calves are removed from the cow about 48 hours after birth. For this reason, it does not make sense to let the offspring live with the mature cows. Instead a “dummy” breeder needs to be put in the 1st year pen. This dummy breeder produces one calf per year for each cow in the milker’s pen. In the mod, the milkers only produce milk, they do not breed. After one year, the growers in the 1st year pen are either sold or “moved” to the 2nd year pen. A milker is usually slaughtered after six years. Hence, each year one sixth of the dairy herd need to be replaced by 2nd year heifers. As for the pigs, the growers are not moved physically. Instead they are sold at the 1st year pen and new animals are bought at the 2nd year pen at the same price.

11.5 Large-scale sheep farming

For “large-scale” sheep farming, three specialized pens are needed. Lambs are staying with the ewe the first 4 months. Although lambing is usually limited to a few months in the spring, lambing is here taken to occur all year round. Hence 120 ewes produce 150 lambs, or 50 lambs per 4 months. Every 4 months, 50 lambs are “moved” to the grower’s pen, where they stay for 4 months and are either sold for slaughter or moved to the replacer pen. In this case only one fifth is moved to the replacer’s pen. The rest is sold for slaughter.

Figure 20. Two cow pens back-to-back at Fenton Forest by Stevie.

Figure 21. Two back-to-back sheep pens at Fenton Forest by Stevie.

Like pigs and cows, sheep are not moved physically. Instead 50 sheep are sold at the lambing pen and 50 are bought at the grower's pen for the same price. Likewise, 50 growers are sold at the grower's pen, and 10 are bought at the replacer's pen.

Table 39. Large-scale sheep farming.

	Lambing pen	Grower's pen	Replacer's pen
Animal color	Brown	Black-White	Black
Breeding cycle (months)	12	12	12
Litter size	1.25	0	0
Offspring months in pen	4	4	4
Mature animals (breeding)	120	0	0
Offspring (non-breeding) per pen stay	50	0	0
Added offspring per pen stay	0	50	10
Removed offspring per pen stay	0	50	10
Starting weight (kg)	0	21	44
End weight (kg)	21	44	66

11.6 Large-scale chicken farming

Chicken farming is either egg production or meat production. The same type of chicken is not used for both. Here, we facilitate both, but in separate pens and with separate chicken subtypes.

Figure 22. Two of three chicken pens at Fenton Forest by Stevie.

Two pens are used in the egg production line. Forty 1-day old chicks are bought every month. When 4 months old, all 40 are "moved" to the layers pen, where they stay for one year. After a phasing-in period of 4 months there will be 160 chickens in the chick pen, and after one year, 480 in the layer's pen. After one year and 4 months, 40 layers are sold for slaughter every month.

In the broiler pen, chickens are bought in as 1-day old and sold for slaughter when 4 months old. If you add and remove 100 every month, you will be replacing 25% of the flock.

Table 40. Large-scale egg and chicken farming.

	Chick pen	Layer's pen	Broiler's pen
Animal color	White	Brown	Rooster
Breeding cycle (months)	12	12	12
Litter size	0	0	0
Offspring months in pen	4	12	4
Mature animals (breeding)	0	0	0
Offspring (non-breeding) per pen stay	0	0	0
Added offspring per month	40	40	400
Removed offspring per month	40	40	400
Starting weight (kg)	0.05	1.4	0.05
End weight (kg)	1.4	2.6	2.6

It is likely to be a time-consuming job to do large scale farming of more than one type of animal. Nevertheless, large scale farming of both pigs, cows, sheep and chicken will require 12 pens, in addition to perhaps a horse pen. The game limit on husbandries is by default 10. The mod increases this to 20 to give room for ambitious farming plans.

11.7 Animal input

For all animals, water, straw and feed consumption as well as waste production are separate for mature and growing animals. For growing animals, the feed amount consumed, or waste produced is based on the range of weight according to weight charts.

Table 41. 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

Bedding straw for pigs are set to 2 kg per real-life day per mature pig and 0.9 kg for growers.

Water and feed intake are calculated separately for mature animals and offspring and added together. The total feed is subdivided into 50% maize, 25% grain, 20% protein, and 5% root crop. Dividing the volumes of individual foods by their yield per hectare, we get how much field area is needed to produce the different types of feed ingredients.

Water intake by pigs and cows is very large. To avoid having to spend too much time driving a water bowser to the water trough, it is assumed that a major fraction of all water intake is obtained from an automatic system, and only a smaller portion from a bowser.

```
RN.pigs.bowserWaterFraction =           0.1;
```

Table 42. Weight chart for cows.

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	Milk + Milk replacer and grain starter mix		3.0	91.0
1	119	54	6	180	0.44	19.6			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

For cows, bedding straw is set to 1.4 kg per real-life day per cow. Using the straw bale volume and number of cows we get the total volume of bedding straw per year. The script then calculates how large a wheat, barley or oat field is needed to produce the bedding straw for cows.

Cows drink 4-5 times their milk production, amounting to almost 40000 liters per year, or 100-110 L/real-life day. Calves drinks much less, here set to 4915 liters per year, or 14 L/real-life day averaged over the year. This adds up to a lot of water. Therefore only 10% is to be delivered by a water bowser. The total feed intake of mature cows and offspring are added up to obtain the total cow feed per year. This is a very large amount; hence it is assumed that a fraction is obtained by grazing, and that the rest is given in the trough. The mod user can adjust the trough fraction. Of trough feed, 50% is assumed to be hay, 25% silage and 25% straw (a valid TMR mixing ratio). From the consumed volume of hay, silage and straw, the corresponding number of bales and field areas are calculated.

Table 43. Sheep weight chart.

Months	Weight kg	Feed DM kg/day	Feed DM accum, kg
1	5.0	0.2	6
2	10.5	0.42	18.6
3	16.0	0.64	37.9
4	21.6	0.86	63.7
5	27.1	1.08	96.2
6	32.6	1.30	135.4
7	38.1	1.52	181.1
8	43.6	1.75	233.5
9	49.2	1.97	292.5
10	54.7	2.19	358.1
11	60.2	2.41	430.3
12	65.7	2.63	509.2

For sheep, water intake is calculated separately for mature animals and for offspring. Mature sheep drink about 7 liters of water per day, when lactating and 4 liters per day when dry. Averaged out, this amounts to about 4.75 liters per real-life day. For lambs, growers and finishers, the water intake is set to 0.75, 3.0, and 4.0 L per real-life day (averaged over time). The fresh matter feed intake of mature sheep is set to 10.5 kg and correspondingly less for offspring in accord with their weight chart.

As in Table 43, animal feed intake is often given in dry matter content, as the nutrients are stored in the dry matter part of the feed, not the water content. To get the fresh matter mass you use the equation:

$$Fresh\ matter\ (kg) = \frac{Dry\ matter\ (kg)}{drymatter\ fraction}$$

$$drymatter\ fraction = 1 - moisture\ content$$

An example of the use of these equations is shown in Table 44.

Table 44. Calculation of feed intake for sheep.

Mature sheep weight	120	kg
Dry matter intake per body mass	0.013	
Dry matter intake per day	1.56	kg DM per day
Grass dry matter fraction	0.15	
Grass fresh matter intake	10.40	kg/day
Grass bale density	0.46	kg/L
Grass volume intake	22.61	L/day
Hay dry matter fraction	0.85	
Hay mass intake	1.84	kg/day
Hay bale density	0.16	kg/L
Hay volume intake	11.47	L/day

Here the dry matter intake is set to 1.3% of the sheep's body mass. The water content in pasture grass is set to 85% hence the dry matter fraction is 0.15. To cover the dry matter intake, the sheep will have to eat 22.6 liters of fresh grass, or 11.5 liters of hay. The dry matter concentration in hay is 85%, hence less hay is needed.

The mod user can set how large a fraction of the annual feed should be given in the trough. The mod sets it to 50%. The required number of bales and grassland is calculated.

In FS19, chicken do not take water or straw, only feed. Mature chicken eat about 0.11 kg/day (see Table 45 and Table 46).

Table 45. 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 46. 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

In real-life the amount of straw bedding for horses varies from nothing to one big bale per month depending on the believes of the owner. The concern of straw use regards both the dust from straw

and hay and the unevenness of the floor in deep layers of bedding. The script specifies an amount per game day corresponding to 10% of a straw bale per game day per horse.

Water intake per real-life day is set to 0.084 liters per kg body weight. Feed intake per real-life day is set to 0.025 kg per kg body weight. The feed intake is split into 75% oat and 25% hay.

11.8 Animal output

A mature sow produces about 12 kg manure per real-life day and the offspring about 4 kg. Liquid manure is set to 85% of the water intake for lactating sows and 90% for offspring.

A cow's manure production per year is set to 52 kg per real-life day and for the offspring 13 kg. For lactating cows, the liquid manure production is set to 75% of the water intake. Milk yield is set to 8715 liters/year (Germany).

Table 47. Script output sample for Animal care.

```
cow start number                        =        20
cow end number                          =        40
cow pen capacity                        =       500
cow BirthRatePerDay                     =        0.0613
cow mean number                         =       28.9243
cow time to first birth                 =  19:54:56

Total cow bedding straw per year        =    121846      Liter
Total cow bedding straw bales per year  =        31      bales
Wheat field for cow bedding straw       =        2.8140  Ha
Barley field for cow bedding straw      =        3.4208  Ha
Oat field for cow bedding straw         =        3.9064  Ha

Total cow water per year                =    889920      Liter
Bowser fraction of drinking water       =         0.1000
Total cow bowser water per year         =     88992      Liter

Trough food per year                    =    957273      Liter
Straw fraction of total mixed ration    =         0.2500
Hay fraction of total mixed ration      =         0.5000
Silage fraction of total mixed ration   =         0.2500
Total cow straw feed per year           =    239318      Liter
Total cow hay feed per year             =    478636      Liter
Total cow silage feed per year          =    239318      Liter
Total cow straw bale feed per year      =        60      bales
Total cow hay bale feed per year        =       120      bales
Total cow silage bale feed per year     =        60      bales

Wheat field for cow straw feed          =        5.5270  Ha or
Barley field for cow straw feed         =        6.7189  Ha or
Oat field for cow straw feed            =        7.6726  Ha
Hay field for cow hay feed              =       11.0019  Ha
Grass field for cow silage feed         =        5.5009  Ha

Total milk per year                     =    170049      Liter
Total cow manure per year               =    778800      Liter
Total cow liquid manure per year        =    682128      Liter
cow food spillage per game day          =      137.8991  Liter

cow straw per cow per game day          =      351.0489  Liter
cow water per cow per game day          =      256.3934  Liter
cow feed per cow per game day           =     2757.9826  Liter
```

A sheep's wool production is set to 8.2 kg/year. With a bale density of 0.375 kg/L this amounts to 21.8 liters of a 1000 liter wool pallet. Hence it requires 50 sheep to produce one wool pallet per year; much less than in the standard game. Let me know if this is way off.

Chickens are set to lay 275 eggs per year. One egg is assumed to be 0.05 liters. Hence one layer produces 13.75 liters of egg per year. In FS19 an egg pallet/box is set to contain 75 liters of eggs, corresponding to 1500 eggs.

Horses do not produce output. Food spillage is controllable in the script. It is set to 5%.

```
RN.feedSpillageFraction = 0.05;-- fraction of feed spilled in front of trough
```

12 Animal trade prices

The script **RealNumbersAnimalTradesPrices** sets purchase and sell-prices for animals based on collected data from EUROSTAT and USDA. Such prices are based on the body weight of the animal.

Table 48. Purchase and sell prices for pigs (Germany).

```
Standard

RED fillType                          =        73
RED animalMatureWeight                =       180      kg
RED animalBuyWeight                   =    180.0000    kg
RED animalSellWeight                  =     81.0000    kg
RED buyprice                          =    239.4000 €/head
RED sellprice                         =    107.7300 €/head
RED transportFee                      =     10.0000 €/head


Sows+Piglets

WHITE fillType                        =        74
WHITE animalMatureWeight              =       180      kg
WHITE animalBuyWeight                 =      1.0000    kg
WHITE animalSellWeight                =     21.0000    kg
WHITE buyprice                        =      1.3300 €/head
WHITE sellprice                       =     27.9300 €/head
WHITE transportFee                    =      0.0000 €/head


Growers

BLACK_WHITE fillType                  =        75
BLACK_WHITE animalMatureWeight        =       180      kg
BLACK_WHITE animalBuyWeight           =     21.0000    kg
BLACK_WHITE animalSellWeight          =     47.0000    kg
BLACK_WHITE buyprice                  =     27.9300 €/head
BLACK_WHITE sellprice                 =     62.5100 €/head
BLACK_WHITE transportFee              =      0.0000 €/head


Finishers

BLACK fillType                        =        76
BLACK animalMatureWeight              =       180      kg
BLACK animalBuyWeight                 =     47.0000    kg
BLACK animalSellWeight                =     81.0000    kg
BLACK buyprice                        =     62.5100 €/head
BLACK sellprice                       =    107.7300 €/head
BLACK transportFee                    =      0.0000 €/head
```

Although animal transfer from one pen type to the next is orchestrated by selling and buying animals, no actual expense is associated with this. Table 48 illustrates this as the sell price of piglets equals the buy price of growers and the sell price of growers equals the buy price of finishers. To keep the expense of animal transfer neutral, the transport fee is set to zero for these animal subtypes.

13 Field information

Different countries do different types of farming. In Table 49 it is seen that 98.5% of all farmland is arable land in Finland, whereas 79% of all farmland is grassland in Ireland.

Table 49. 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 23.

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 50).

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. The concept of renting is here much simpler than the principle of renting equipment in the game. There is no option for returning usage privilege of the field to its owner. It is simply a field at a reduced cost of use.

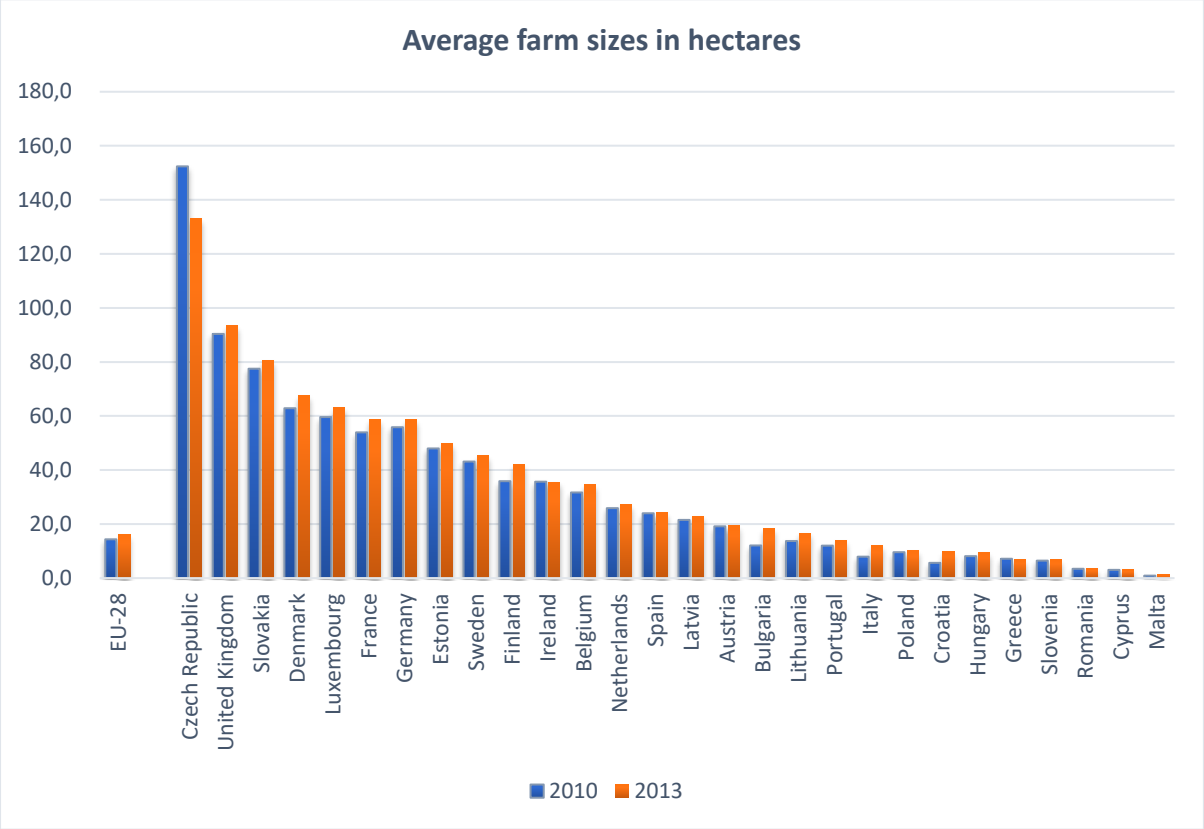

Figure 23. Average land area on farms in EU.

Table 50. 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
```

To have an idea about how much field work lies ahead, Table 51 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.

People playing the game for the money challenge might consider renting fields at a lower cost cheating. But this mod is not intended to be of any service to such a game style, so if a player feels uneasy using such options, it is easy to disable the mod.

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 leftAlt-rf**, i.e. the left Alt key is held down while pressing r and f.

Table 51. Summary of crop area on farm.

Total farmland area owned/rented	=	97.7	Ha
Total field area owned/rented	=	53.1	Ha
Grain crop area	=	22.7	Ha
Row grain crop area	=	5.2	Ha
Potato area	=	0.6	Ha
Sugarbeet area	=	0.0	Ha
Grass area	=	9.0	Ha
Cotton area	=	0.0	Ha
Sugarcane area	=	0.0	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 52).

Table 52. 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 52, 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 24. Another day on the farm. Fenton Forest by Stevie.

Figure 25. Before the error causing an excessive production of wool was fixed.

14 Contracts

The final 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 has to 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.

Table 53. ArmChairFarming Agricutural Services. 2019 price list.

mow_bale farmServicePerHa	=	200	€/Ha	weed farmServicePerHa	=	20	€/Ha
mow_bale hectares per hour	=	1	Ha/hour	weed hectares per hour	=	5	Ha/hour
mow_bale vehicle use cost per hour	=	20	€/hour	weed vehicle use cost per hour	=	10	€/hour
mow_bale salary per hour	=	50	€/hour	weed salary per hour	=	20	€/hour
mow_bale start fee	=	10	€/hour	weed start fee	=	10	€/hour
plow farmServicePerHa	=	100	€/Ha	spray farmServicePerHa	=	25	€/Ha
plow hectares per hour	=	1	Ha/hour	spray hectares per hour	=	5	Ha/hour
plow vehicle use cost per hour	=	10	€/hour	spray vehicle use cost per hour	=	10	€/hour
plow salary per hour	=	10	€/hour	spray salary per hour	=	50	€/hour
plow start fee	=	10	€/hour	spray start fee	=	10	€/hour
cultivate farmServicePerHa	=	30	€/Ha	fertilize farmServicePerHa	=	25	€/Ha
cultivate hectares per hour	=	3	Ha/hour	fertilize hectares per hour	=	5	Ha/hour
cultivate vehicle use cost per hour	=	10	€/hour	fertilize vehicle use cost per hour	=	10	€/hour
cultivate salary per hour	=	10	€/hour	fertilize salary per hour	=	10	€/hour
cultivate start fee	=	10	€/hour	fertilize start fee	=	10	€/hour
sow farmServicePerHa	=	40	€/Ha	harvest farmServicePerHa	=	150	€/Ha
sow hectares per hour	=	2	Ha/hour	harvest hectares per hour	=	1	Ha/hour
sow vehicle use cost per hour	=	10	€/hour	harvest vehicle use cost per hour	=	20	€/hour
sow salary per hour	=	10	€/hour	harvest salary per hour	=	20	€/hour
sow start fee	=	10	€/hour	harvest start fee	=	10	€/hour
transport fee per object	=	3	€/object				
transport default duration	=	1	hour(s)				
transport vehicle use cost per hour	=	5	€/hour				
transport salary per hour	=	10	€/hour				
transport start fee	=	5	€/hour				

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.

Table 54. Example contracts. In multiplayer mode, this information is not shared with client computers.

```
harvest field                          =         5
harvest crop: CANOLA                   =         5
harvest field area                     =       6.1730 Ha
harvest fertilizer state               =        50    %
harvest lime state                     =       100    %
harvest herbicide state                =       100    %
harvest plow state                     =       100    %
harvest yield factor                   =       175    %
harvest salary per Ha                  =      20.0000 €/Ha
harvest start fee                      =      10.0000 €
harvest labor total                    =     123.4605 €
harvest vehicle use cost               =     123.4605 €
harvest farmService                    =     925.9538 €
harvest total                          =    1182.8747 €
harvest deliver to EDEKA
harvest crop price/ha                  =    1104.1858 €/Ha
harvest max yield/ha                   =    4789.3133 L/Ha
harvest max crop price                 =    6816.1663 €
harvest max yield                      =   29564.5506 L
harvest expected yield                 =   25868.9818 L
harvest standard crop price/L          =       0.2306 €/L
harvest expected crop price            =    5964.1455 €
```

```
fertilize crop: COTTON                 =         4
fertilize field area                   =       1.9373 Ha
fertilize fertilizer state             =         0    %
fertilize lime state                   =       100    %
fertilize herbicide state              =       100    %
fertilize plow state                   =       100    %
fertilize yield factor                 =       150    %
fertilize salary per Ha                =       2.0000 €/Ha
fertilize start fee                    =      10.0000 €
fertilize labor total                  =       3.8746 €
fertilize vehicle use cost             =       3.8746 €
fertilize farmService                  =      48.4325 €
fertilize fertilizer cost              =     960.6344 €
fertilize total                        =    1026.8161 €
fertilize fertilizer liter/ha          =    1311.8056 L/Ha
fertilize fertilizer cost/Liter        =       0.3604 €/L
fertilize fertilizer cost/ha           =     472.7730 €/Ha
```

For contracts like seeding, fertilizing, and spraying, the contractor delivers the seed, fertilizer and herbicide. As seen in the example contracts in Table 54, 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 current mod adds the reimbursement to the “reward” variable, such that full payment is secured.

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. The motivation for this policy is unknown.

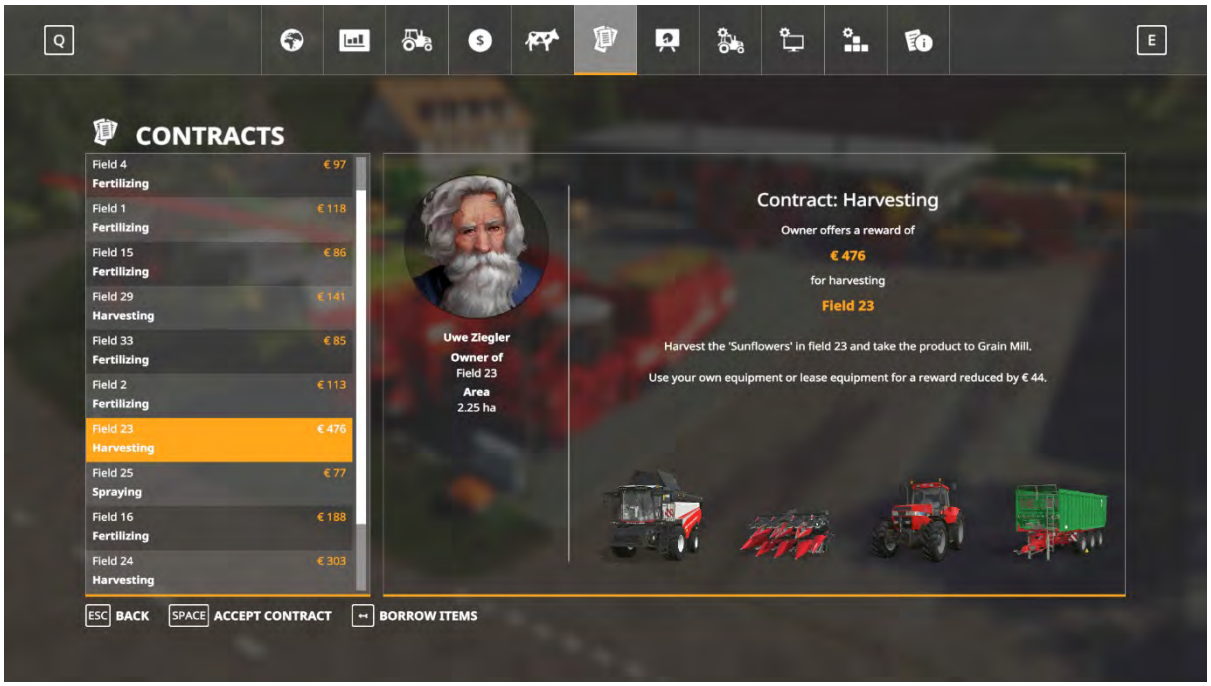

Figure 26. Contracts to be signed.

The contracting feature involves a lot of synchronization between host and clients when playing in multiplayer mode. The itemized contracts (Table 54) is not distributed to client PCs in this mod. 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.

15 Vehicle maintenance

In FS19 the service interval is set to 8 to 10 hours. Some players find this to be too short. The script **RealNumbersVehicleMaintenance** redefines the service interval. The parameter is set in **RealNumbersInitialization**:

```
RN.vehicleServiceInterval     = 100;      -- hours between repairs
RN.fieldMultiplier            = 2;        -- default 2
RN.workMultiplier             = 5;        -- default 20
```

16 Planning a large pig farm

Note: The sections on planning are based on 4000 L bales.

The log file is full of useful numbers. Let us first use it to make predictions on farmland need for a large-scale pig farm (Table 55).

Table 55. Field sizes required to feed a large pig herd (4000 L bales).

	Sow+Piglets	Growers	Finishers	Total	
Pig start number	14	0	0		
Pig end number	196	104	104		
Pig mean number	118	104	104	326	
Bedding	83	54	108	245	Bales
Bedding straw land	7.6	5.8	11.5	24.9	Hectares
Grain feed	16477	25920	53280	95677	Liters
Maize feed	32954	51840	106560	191354	Liters
Protein feed	13182	20736	42624	76542	Liters
Root crop feed	3295	5184	10656	19135	Liters
Grain feed land	2	3.1	6.4	11.5	Hectares
Maize feed land	2.2	3.4	7	12.6	Hectares
Protein feed land	2.1	3.3	6.9	12.3	Hectares
Root crop feed land	0.03	0.05	0.1	0.18	Hectares
Manure	163800	230880	492960	887640	Liters
Slurry	133938	134784	235872	504594	Liters

There are about 325 pigs on the farm, and they use 245 straw bales for bedding in one year. It takes about 25 hectares of grain crop to produce this number of straw bales. About 50 hectares of field area is required. There will be plenty of organic fertilizer.

17 Planning a large dairy farm

As another example of use of all the information printed in the log file, let use predict the feed consumption and field sizes required to feed the cows on a large-scale dairy farm (Table 56).

Table 56. Field sizes required to feed a large dairy herd (4000 L bales).

	Milkers	1st year	2nd year	Total	
cow start number	96	1	0		
cow end number	96	97	16	209	
cow mean number	96	22	16	134	
Bedding	94	52	16	162	Bales
Bedding straw land	8.6	4.8	1.5	14.9	Hectares
Straw feed	216	72	26	314	Bales
Hay feed	432	143	52	627	Bales
Silage feed	216	72	26	314	Bales
Straw feed land	20	6.6	2.4	29	Hectares
Hay feed land	40	13	4.7	57.7	Hectares
Silage feed land	20	6.6	2.4	29	Hectares
Milk yield	816234	0	0	816234	Liters
Manure	3012480	725760	336000	4074240	Liters
Slurry	2851200	423014	155520	3429734	Liters

Table 56 shows the number of bales and hectares of fields needed to feed close to 100 dairy cows and an equal number of calves for one year. It has been assumed that grass fields can be cut two times in a year. The totals are very large because the mod assumes that 50% of all cow feed is given in the trough. The user can adjust the trough fraction as seen fit. It takes about 45 hectares of grain fields and 90 hectares of grass land to provide 50% of the feed to 208 cows. This is about 1-hectare grass land to 1.2 cows.

In a well-managed pasture rotation system, 1 hectare of pasture can feed 2 – 2.5 dairy cows (a stocking rate of 2 – 2.5) during the grazing season. A stocking rate of 1 equals one livestock unit per hectare. A livestock unit is the amount of feed energy consumed by a mature Holstein dairy cow. The livestock unit of all other grazing animals are then relative to that of a Holstein dairy cow (Table 57).

Table 57. Livestock units and stocking rate for cattle[3].

Cattle	**Livestock unit**	**Stocking rate**
Holstein dairy cow	1.00	2
Beef cow	0.75	2.66
Beef bull	0.65	3.1
Heifer in calf	0.80	2.5
Other cattle 0 – 12 months	0.34	5.8
Other cattle 12-24 months	0.65	3.1
Barley beef	0.47	4.2

[3] http://beefandlamb.ahdb.org.uk/wp/wp-content/uploads/2016/07/BRP-Planning-grazing-strategies-manual-8-150716.pdf

The grass land to cow rate we calculated (to be 1 ha : 1.2 cows) is not directly comparable to the stocking rate, as the former include all year feed intake and the latter just feed intake during the grazing season.

18 Planning a large sheep farm

For a large-scale sheep farm the amount of grass land amounts to 1-hectare grass land for each 3.4 sheep. The numbers given in Table 58, are calculated based on the assumption that 100% of the feed is given in the trough.

Table 58. Bales and field size requirements for a large sheep farm with 100% trough feed (4000 L bales).

	Lambing	Growers	Replacers	Total	
Sheep start number	120	0	0		
Sheep end number	170	50	10		
Sheep mean number	144	50	10	204	
Grass bales	270	32	11	313	Bales
Hay bales	270	32	11	313	Bales
Grass feed land	25.5	3.2	1	29.7	Hectares
Hay feed land	24	3.0	0.93	27.9	Hectares

If all feed is given in the trough, 200 sheep requires about 60 hectares of grass land.

Table 59. Livestock units and stocking rate for sheep[4].

Sheep	**Livestock unit**	**Stocking rate**
Holstein dairy cow	1.00	2
Lowland ewes	0.11	18.2
Upland ewes	0.08	25
Hill ewes	0.06	33
Rams	0.08	25
Store lambs 0 – 12 months	0.04	50
Breeding ewe hoggs 6 – 12 months	0.06	33
Other sheep more than 1 year old	0.08	25

The high stocking rate seen in Table 59 suggests that trough feed should be significantly smaller than 100%. If sheep feed is 100% grazing for 8 months and 50% for 4 months, trough feed would be $0.5 \times 0.33 = 0.167$ or 16.7% of the annual feed intake (see Table 60).

Table 60. Bales and field size requirements for a large sheep farm with 17% trough feed (4000 L bales).

	Lambing	Growers	Replacers	Total	
Sheep start number	120	0	0		
Sheep end number	170	50	10		
Sheep mean number	144	50	10	204	
Grass bales	46	6	2	54	Bales
Hay bales	46	6	2	54	Bales
Grass feed land	4.9	0.57	0.19	5.66	Hectares
Hay feed land	4.6	0.54	0.18	5.32	Hectares

[4] http://beefandlamb.ahdb.org.uk/wp/wp-content/uploads/2016/07/BRP-Planning-grazing-strategies-manual-8-150716.pdf

With 17% trough feed, 11 hectares of grass and is needed. The grass land to sheep rate for trough feed is about 1 ha: 10 sheep.

19 Matching feed requirements to land ownership

Having obtained an idea about the land area needed to feed the herds, the next step is to investigate, if you have enough land or if more should be purchased or rented.

By pressing leftAlt-rf after game start, the mod will print out an overview of land ownership to the log file. An example is shown in Table 61. Obviously, this tycoon has taken it all.

Table 61. Overview of land ownership.

```
Map                  : Fenton Forest By Stevie. Savegame 8
Money                : 2761248
Economic difficulty  : 3
Sell price multiplier : 1
Buy price multiplier  : 1
Current game day      : 2
Time of day           : 15:53

Mean land purchase price = 25000 €/ha
Mean land rent price = 625 €/ha
Field  1: Landarea = 43.1 ha, Fieldarea =  9.0 ha, Price = 1086658 €,  Owned   , Fruittype: Undefined
Field  2: Landarea = 43.1 ha, Fieldarea =  5.7 ha, Price = 1086658 €,  Owned   , Fruittype: Undefined
Field  3: Landarea =  7.8 ha, Fieldarea =  4.3 ha, Price =  185361 €,  Owned   , Fruittype: WHEAT
Field  4: Landarea =  9.9 ha, Fieldarea =  7.6 ha, Price =  254733 €,  Owned   , Fruittype: BARLEY
Field  5: Landarea = 12.9 ha, Fieldarea =  5.6 ha, Price =    8405 €,  Rented  , Fruittype: Undefined
Field  6: Landarea = 14.9 ha, Fieldarea = 12.1 ha, Price =  391847 €,  Owned   , Fruittype: Undefined
Field  7: Landarea = 10.1 ha, Fieldarea =  8.4 ha, Price =  253189 €,  Owned   , Fruittype: CANOLA
Field  8: Landarea = 10.0 ha, Fieldarea =  3.6 ha, Price =  241451 €,  Owned   , Fruittype: GRASS
Field  9: Landarea = 14.2 ha, Fieldarea = 11.9 ha, Price =    8499 €,  Rented  , Fruittype: SOYBEAN
Field 10: Landarea =  4.7 ha, Fieldarea =  3.5 ha, Price =  114706 €,  Owned   , Fruittype: MAIZE
Field 11: Landarea = 17.3 ha, Fieldarea = 11.6 ha, Price =  446407 €,  Owned   , Fruittype: POTATO
Field 12: Landarea = 16.7 ha, Fieldarea =  6.5 ha, Price =  437579 €,  Owned   , Fruittype: Undefined
Field 13: Landarea = 22.2 ha, Fieldarea = 11.8 ha, Price =  569906 €,  Owned   , Fruittype: WHEAT
Field 14: Landarea = 11.2 ha, Fieldarea =  4.4 ha, Price =    6680 €,  Rented  , Fruittype: BARLEY
Field 15: Landarea = 27.8 ha, Fieldarea = 15.0 ha, Price =  695708 €,  Owned   , Fruittype: OAT
Field 16: Landarea = 15.0 ha, Fieldarea =  8.8 ha, Price =    9659 €,  Rented  , Fruittype: COTTON

---Owned land and crop area---

Total farmland area owned/rented         =     281.0  Ha
Total field area owned/rented            =     129.7  Ha
Grain crop area                          =      63.4  Ha
Row grain crop area                      =       3.5  Ha
Potato area                              =      11.6  Ha
Sugarbeet area                           =       0.0  Ha
Grass area                               =       3.6  Ha
Cotton area                              =       8.8  Ha
Sugarcane area                           =       0.0  Ha

Field  1: Usability ratio =   0.2082
Field  2: Usability ratio =   0.1334
Field  3: Usability ratio =   0.5475
Field  4: Usability ratio =   0.7755
Field  5: Usability ratio =   0.4328
Field  6: Usability ratio =   0.8068
Field  7: Usability ratio =   0.8287
Field  8: Usability ratio =   0.3578
Field  9: Usability ratio =   0.8375
Field 10: Usability ratio =   0.7379
Field 11: Usability ratio =   0.6715
Field 12: Usability ratio =   0.3918
Field 13: Usability ratio =   0.5331
Field 14: Usability ratio =   0.3874
Field 15: Usability ratio =   0.5388
Field 16: Usability ratio =   0.5851
```

While this farmer has plenty of land, we observe that out of 281 ha owned, only 130 ha is usable field area. We also see from the middle part of the table, that the farmer has 3.6 ha grass land, not sufficient to feed cows or sheep in a large-scale farming setup. In FS19 the large amount of grass around fields seems to suggest that such wild grass is suitable feed for animals. It might be for

sheep, but in many countries, farmers are very particular about the type of grass they feed their dairy herd, and wild grass is not on the menu.

Before going out and buying more expensive land, it is wise to look at how good use you make of the land you already own. The usability ratio listed at the bottom of Table 61 is simply the field area divided by the land area. For field 1 this is about 20% while for field 9 it is almost 84%. If you want to convert owned land to field area, bringing the plough to field 1 would give you the largest increase in total field area.

If on the other hand, you were looking at buying more farmland and do not want to spend time ploughing the unused part of the land, buying field 9 would give you the most field area for your money.

If helper friendly fields are top priority, then land conversion is often not an attractive option, and you should buy/rent fields with a high usability ratio.

20 End notes

A lot more could have been done, and things could have been more streamlined. 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 27. The first rain in 120 days.

21 Appendix

Table 62. Pig terminology[5].

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.

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

Table 63. 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 64. 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[6]. Additional good readings are listed in the footnotes[7,8,9].

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