INSTITUTE of TECHNOLOGY CARLOW

Institiúid Teicneolaíochta Cheatharlach

Name : Damien Doran

Student Number : C00221791

Project title : Teagasc app

Document : Research Document

Date : 2020/2021

Abstract:

This is a web application whose target audience is Teagasc Advisors assisting low production farmers such as beef/ sheep farmers.

This is designed to work alongside the current web application NMP (Nutrient Management Planning) rather than replace it due to having different target audiences. There is currently an excel sheet in which advisors use to carry out certain functions for low production farmers.

This research document shows a comparison of the 2 systems which are currently in use, and they perform their functionality for their target audience. There is also a comparison done to what's in other countries.

The research document shows where the application was going and how it was beginning to look very similar to what was in the system.

I have also gone into the calculations giving an example to fully explain the calculations. This shows how the figures can be manipulated and edited by using a different feature or how location affects the calculation.

Finally I have included the future of the application and what features can be added to improve its level of functionality.

Due to this being a document with technical scientific language I have included a useful definition and acronym section before references.

There is also an appendix section with emails from various advisors stating their opinion on the web application.

Table of Contents

1.0 Introduction **7**
1.1 Teagasc app overview 7
1.2 Meetings with Robert Sherriff: 7

2.0 The Excel System **8**
2.1 Pros 11
2.2 Cons 11

3.0 Overview of the Microsoft Excel sheet **11**
3.2 Transitional rule: 13
3.3 Monthly livestock calculator: 15
3.4 Tillage: 16
3.5 Fertilizer Grassland 18
3.6 Fertilizer Tillage 19
3.7 Slurry Storage 20
3.8 Fertilizer Records 22
3.9 Conclusion: 25

4.0 The NMP Online Application **26**
4.1 NMP's current functionality includes: 26
4.2 Pros 27
4.3 Cons 27

5.0 Overview of website NMP (Nutrient Management Planning) **28**
5.2 Soil Samples 30
5.3 Land Set-up 31
5.5 Organic fertiliser Import 34
5.6 Organic fertiliser Export 35
5.7 Organic N and P summary 36
5.8 Concentrate feeds 36
5.9 Winter Housing 37
5.10Manure Storage 38
5.10.1 Storage Requirements 38
5.11 Soiled water 39
5.11.1 Winter Diary Herd 39
5.11.2 Soiled Water Locations 40
5.11.3 Collecting yard 41
5.11.4 Storage 42
5.12 Yard Manure 42
5.12.1 Farm Yard Manure Production 42
5.12.2 Straw requirement 42
5.12.3 FarmYard Manure Storage 43
5.12.4 FarmYard Manure Storage 43
5.13 Slurry 44

5.13.1 Slurry Produced 44
5.13.2 Slurry Storage Available 44
5.13.3 Slurry storage Balance 44
5.14 Farm Yard Map 44
5.15 Storage Summary 44
5.16 Fertiliser plan 44
5.16.1 Cereal Crop yields 44
5.16.2 Lime 45
5.16.3 Fertiliser Plan- Land and Fert Max 45
5.16.4 Organic fertiliser 45
5.16.5 Chemical fertiliser 46
5.16.6 Fertiliser Plan Summary 47
5.17 Map Viewer 47
5.17.1 Adding information to the map 47

6.0 Explanation of Calculations: Nitrates **48**
6.1 Nitrates figures: 48
6.2 Grassland Stocking Rate 49
6.3 Whole farm stocking rate 49
6.4 Livestock unit per hectare 49
6.5 Record 5 Land 50
6.6 Imports 51
6.6.1 Slurry: Nitrates 51
6.6.2 Farm Yard Manure: Nitrates 51
6.7 Exports 51
6.7.1 Slurry: Nitrates 51
6.7.2 Farm Yard Manure: Nitrates 52

7.0 Explanation of Calculations: Phosphates **52**
7.1 Phosphate figures: 52

9.0 Key spreading dates per zone: **53**
9.1 Zone A: 53
9.2 Zone B: 53
9.3 Zone C: 54
9.4 Prohibited application period: 54

10.0 What's used in other countries? **55**

11.0 Motivation **55**

12.0 My Proposal **55**

13.0 How it works **56**

14.0 Technologies **60**
14.1 Python 60
14.2 Javascript 60

14.3 Flask 60
14.4 Django 61

15.0 Potential Database Technologies **61**
15.1 SQLite 61
15.2 MySQL 61
15.3 Final Decision 62

16.0 Summary and Conclusion: **62**

17.0 Plagiarism Declaration **63**

18.0 Bibliography: **63**
18.1 Useful Acronyms 63
18.2 Useful Definitions 64

20.0 Appendix **65**

21.0 References **68**

Table of Figures:

Fig: A: Page 10
Fig B: Page 14
Fig C: Page 15
Fig D: Page 17
Fig E: Page 18
Fig F: Page 19
Fig G: Page 20
Fig H:Page 22
Fig I: Page 22
Fig J: Page 23
Fig K:Page 24
Fig L: Page 25
Fig M: Page 26
Fig N: Page 27
Fig O: Page 29
Fig P:Page 29
Fig Q: Page 30
Fig R: Page 31
Fig S: Page 32
Fig T: Page 33
Fig U: Page 34
Fig V: Page 35
Fig W: Page 35
Fig X: Page 36
Fig Y: Page 36
Fig Z: Page 37
Fig: AA: Page 38
Fig AB: Page 39
Fig AC: Page 40
Fig AD: Page 41
Fig AE: Page 42
Fig AF: Page 43
Fig AG: Page 45
Fig AH: Page 46
Fig AI :Page 47
Fig AJ: Page 48

Table 1: Nitrates Information: Page 48
Table 2: Phosphates Information: Page 52
Table 3: Commencement and end date for various fertilizers per zone; Page 54

Appendix 1: Email from Martin Doyle; Dairy Advisor: Page 64
Appendix 2: Email from James Doran;Beef Advisor; Page 64
Appendix 3: Email from Tom Deane; Drystock Advisor: Page 65
Appendix 4: Email from Deidre Doyle; Beef advisor: Page 65

Appendix 5: Email from Mark Boland: Agricultural Catchments Programme Advisor: Page 66

1.0 Introduction

1.1 Teagasc app overview

This research document contains all the relevant research involved in this project . Descending from an Agricultural background I wanted to design, develop or produce software that would help in the agricultural sector. After current pandemics, harsh weather and other situations that exist in day to day life, the importance of farming goes unnoticed.

In my local area, Teagasc, a semi-state advisory body [1] designated to assess the needs and wants of farmers while ensuring to maintain within the legal limits. In Ireland a farmer will have a stocking rate (Amount of animals grazing on certain areas of land in a certain time frame [8]). Most stocking rates in Ireland legally have to be below 170 kg of nitrogen per hectare [9].The farmers stocking rate will measure how much nitrogen is excreted by animals per hectare on his farm [10]. If farmers fail to comply with this legislation they will receive a 15 % penalty. If the farmer continues to not comply penalties will increase and on year 3 the farmer will receive a 100% penalty [16].

After arranging a meeting with one of the Head Advisors Robert Sheriff [61] I was able to propose my idea for a mobile web app designed around helping advisors carry out assessments. After discussing this with Robert it proved infeasible as the majority of the work needs to be done within the office, so a proposal for a web app was put forward and after a brief discussion a template was agreed upon although I have been given control over the main layout, functionality and design of the app.

Currently in Teagasc there are 2 systems for assisting farmers. i.e the farmer may want to clarify his stocking rate, to ensure he has enough slurry/ farmyard manure storage for the winter period. The first and original functioning system was designed in Microsoft Excel yet it is showing its age. The system is an online web app designed around high production farmers who are exceeding limits legally. To fully investigate the current two systems and to ensure a more satisfying user experience, a pros, cons comparison list will be constructed for a better understanding of where upgrades will best suit the farmer and advisors needs.

1.2 Meetings with Robert Sherriff:

Robert Sherriff [61] has been a drystock/ sheep advisor in various Teagasc offices for many years. Due to his high level of expertise in this area which he has built up over the years I decided to arrange a meeting with him to discuss ideas for a potential application. I was open to the idea of either phone or web application depending on what was needed.

Our first meeting was held last September when he discussed many ideas, discussing what was currently there and what is needed to make life more convenient for advisors and farmers. We came to the conclusion that Teagasc Advisors Application was a web application that is needed and would be used on a regular basis. Leaving the meeting that day I was given an Excel sheet which would be my functionality guide.

Once I had the first feature completed- whole farm stocking rate and grassland stocking rate I rearranged another meeting with Robert which was held on March 1st. Up until then communication was through emails and phone calls. Initially the project aimed to match the excel sheet in terms of functionality which I believed to be what was requested yet at the meeting Robert was happy with the current look and feel of the application yet felt that it was going in the wrong direction. Somewhere during the designing of the application and researching an Advisors role in assessing farmers I lost track of the main requirements of the app in regards to the needs of Teagasc. At the meeting Robert explained that his vision of this app would be designed for swift informative report, and would perform 6 main features :

- Grassland Stocking Rate (this is total Nitrates which is produced by grazing animals on the grassland section on the farm divided by total area of grassland) .

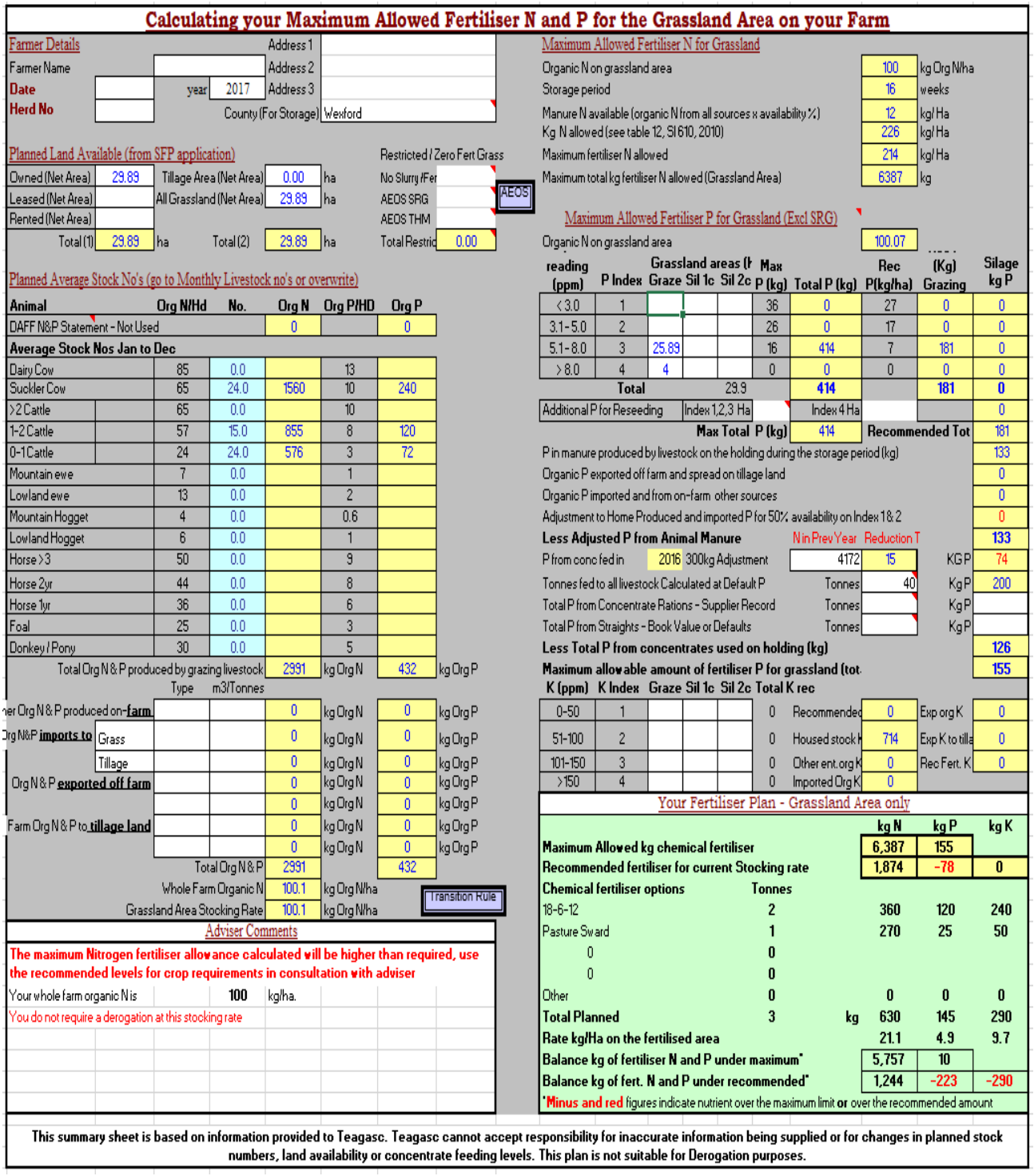
  Whole farm Stocking Rate(this is the total nitrates produced by grazing animals. The nitrates figure will be adjusted if the farmer is exporting/ importing farmyard manure/ slurry. The total nitrates will be divided by the total farm area)

- Record 5 land (this is land rented on a short term basis)
- Livestock unit per hectare (type of stocking rate)
- Slurry/ farmyard manure Storage
- Import / Export of slurry/ farmyard manure
- Fertiliser Plan

2.0 The Excel System

The first system built was within Excel and consisted of several pages (several worksheets in the same excel file) designed for calculations. The Excel system is rarely used as it has been without update for quite some time, it is slightly faster than the newer system as less input data is required, but due to the age of the system it has become harder for people to use, due to small text, several unlabeled boxes and a majority of advisors (this is a profession who will advise/ assist a farmer on technical/ business matters and offer solutions[11]) have a distaste for Microsoft Excel and prefer a more modern aesthetically pleasing system.

The Excel sheet is extremely accurate and reliable when it comes to calculating Stocking rates, Nitrogen and Phosphate levels (the limit of nitrogen which can be applied on land is limited to 170 kgs Nitrogen per hectare. While the limit of phosphate takes into consideration soil samples, levels of concentrates fed to animals[12] and reseeding[13]) yet fails when the assessment concludes due to lacking a print option for a more customer friendly report. Below I have included a page from the Excel system **Fig[A]** to illustrate my findings.



Calculating your Maximum Allowed Fertiliser N and P for the Grassland Area on your Farm

Farmer Details

Farmer Name		Address 1	
Date	year 2017	Address 2	
Herd No		Address 3	
		County (For Storage)	Wexford

Planned Land Available (from SFP application)

Owned (Net Area)	29.89	Tillage Area (Net Area)	0.00	ha	Restricted / Zero Fert Grass
Leased (Net Area)		All Grassland (Net Area)	29.89	ha	No Slurry /Fer
Rented (Net Area)					AEOS SRG
					AEOS THM
Total (1)	29.89	ha Total (2)	29.89	ha	Total Restric 0.00

AEOS

Planned Average Stock No's (go to Monthly Livestock no's or overwrite)

Animal	Org N/Hd	No.	Org N	Org P/HD	Org P
DAFF N&P Statement - Not Used			0		0
Average Stock Nos Jan to Dec					
Dairy Cow	85	0.0		13	
Suckler Cow	65	24.0	1560	10	240
>2 Cattle	65	0.0		10	
1-2 Cattle	57	15.0	855	8	120
0-1 Cattle	24	24.0	576	3	72
Mountain ewe	7	0.0		1	
Lowland ewe	13	0.0		2	
Mountain Hogget	4	0.0		0.6	
Lowland Hogget	6	0.0		1	
Horse >3	50	0.0		9	
Horse 2yr	44	0.0		8	
Horse 1yr	36	0.0		6	
Foal	25	0.0		3	
Donkey / Pony	30	0.0		5	
Total Org N & P produced by grazing livestock			2991 kg Org N		432 kg Org P

	Type	m3/Tonnes				
er Org N & P produced on-farm			0	kg Org N	0	kg Org P
Org N&P imports to	Grass		0	kg Org N	0	kg Org P
	Tillage		0	kg Org N	0	kg Org P
Org N & P exported off farm			0	kg Org N	0	kg Org P
			0	kg Org N	0	kg Org P
Farm Org N & P to tillage land			0	kg Org N	0	kg Org P
			0	kg Org N	0	kg Org P
Total Org N & P			2991		432	
Whole Farm Organic N			100.1	kg Org N/ha		
Grassland Area Stocking Rate			100.1	kg Org N/ha		

Transition Rule

Adviser Comments

The maximum Nitrogen fertiliser allowance calculated will be higher than required, use the recommended levels for crop requirements in consultation with adviser

Your whole farm organic N is 100 kg/ha.

You do not require a derogation at this stocking rate

Maximum Allowed Fertiliser N for Grassland

Organic N on grassland area	100	kg Org N/ha
Storage period	16	weeks
Manure N available (organic N from all sources x availability %)	12	kg/ Ha
Kg N allowed (see table 12, SI 610, 2010)	226	kg/ Ha
Maximum fertiliser N allowed	214	kg/ Ha
Maximum total kg fertiliser N allowed (Grassland Area)	6387	kg

Maximum Allowed Fertiliser P for Grassland (Excl SRG)

Organic N on grassland area 100.07

reading (ppm)	P Index	Grassland areas (h Graze	Sil 1c	Sil 2c	Max P (kg)	Total P (kg)	Rec P(kg/ha)	(Kg) Grazing	Silage kg P
< 3.0	1				36	0	27	0	0
3.1 - 5.0	2				26	0	17	0	0
5.1 - 8.0	3	25.89			16	414	7	181	0
> 8.0	4	4			0	0	0	0	0
Total			29.9			414		181	0
Additional P for Reseeding		Index 1,2,3 Ha				Index 4 Ha			0
					Max Total P (kg)	414	Recommended Tot		181

P in manure produced by livestock on the holding during the storage period (kg)			133
Organic P exported off farm and spread on tillage land			0
Organic P imported and from on-farm other sources			0
Adjustment to Home Produced and imported P for 50% availability on Index 1 & 2			0
Less Adjusted P from Animal Manure	N in Prev Year	Reduction T	133
P from conc fed in 2016 300kg Adjustment	4172	15 KG P	74
Tonnes fed to all livestock Calculated at Default P	Tonnes	40 Kg P	200
Total P from Concentrate Rations - Supplier Record	Tonnes	Kg P	
Total P from Straights - Book Value or Defaults	Tonnes	Kg P	
Less Total P from concentrates used on holding (kg)			126
Maximum allowable amount of fertiliser P for grassland (tot			155

K (ppm)	K Index	Graze	Sil 1c	Sil 2c	Total K rec				
0-50	1				0	Recommended	0	Exp org K	0
51-100	2				0	Housed stock K	714	Exp K to tilla	0
101-150	3				0	Other ent. org K	0	Rec Fert. K	0
>150	4				0	Imported Org K	0		

Your Fertiliser Plan - Grassland Area only

			kg N	kg P	kg K
Maximum Allowed kg chemical fertiliser			6,387	155	
Recommended fertiliser for current Stocking rate			1,874	-78	0
Chemical fertiliser options	**Tonnes**				
18-6-12	2		360	120	240
Pasture Sward	1		270	25	50
0	0				
0	0				
Other	0		0	0	0
Total Planned	3	kg	630	145	290
Rate kg/Ha on the fertilised area			21.1	4.9	9.7
Balance kg of fertiliser N and P under maximum*			5,757	10	
Balance kg of fert. N and P under recommended*			1,244	-223	-290

*Minus and red figures indicate nutrient over the maximum limit or over the recommended amount

This summary sheet is based on information provided to Teagasc. Teagasc cannot accept responsibility for inaccurate information being supplied or for changes in planned stock numbers, land availability or concentrate feeding levels. This plan is not suitable for Derogation purposes.

FIG [A][2]

Fig [A] is a sample of a worksheet which is in the Microsoft Excel system. This page is vital for the other worksheets. Data such as location, concentrates fed, organic Nitrogen and Phosphorus will be used in other locations.

In order to consider this webapp to be an upgrade to the existing system, thorough investigation into the existing software will be required. The first system investigated was the Excel system which has the following functionality :

- Show stocking rate
- Fertilizer plans
- Can display if farmer qualifies for importation/exportation of organic manu
- Displays whether the farmer possesses the required slurry/ farm yard manure storage within the legally closed period

2.1 Pros

- Easy to input data
- Only relevant data required- not every spreadsheet will need to be filled in to get the desired result
- Suited to low production farmers

2.2 Cons

- Can't import soil samples (requires manual inputting)
- Missing lime requirements
- Reports cannot be printed

3.0 Overview of the Microsoft Excel sheet

3.1 Grassland:

When the advisor begins to fill in this sheet he will fill in the farms location.Farm location will become important in a later worksheet when discussing slurry/ farm yard manure storage.

The advisor will then begin to fill in the farmers livestock numbers. Animals will be broken down into categories depending on purpose, animal and age;

- Dairy cows
- Suckler cows
- Stock bulls
- Heifers (1-2 years)
- Heifers (2 years plus)

- Bulls (1-2 years)
- Bulls (2 years plus)
- Calves,
- Lowland ewes
- Highland ewes,
- Lowland hogget
- Highland hogget
- Lowland rams
- Highland rams
- Lambs
- Horses (3 years plus)
- Horses (2 years)
- Horses (1 year)
- Foal
- Ponies/Donkey

Figures given here will be an average for the year. Bovine (members of cattle group [40]) figures can be taken from the Department of Agriculture's website. Once livestock numbers are calculated the total organic Nitrate and Phosphate level is calculated. Each type of animal will produce various amounts of each element. This will depend on livestock type, role of livestock, and age [30]. This will generate a total organic Nitrogen and Phosphate figure which has been produced and excreted by the livestock.

Soil results can also be added to this section. If no soil results are present then the entire farm will be graded at an Index 3 (optimum level for all nutrients and minimum fertilizer is required [28]). This may have a reduction in the level of chemical phosphate which can be bought.

A reseed (this is ploughing a field and reapplying grass seed for the following year. This will achieve higher growth rates and better quality grass [27]) which has been conducted on the farm within the previous 2 years will automatically allow an increased level of Phosphorus to be applied [13].

This page also requires the level of concentrate feeds (this is a feed used alongside a forage to enhance the nutrient balance [31].) Concentrate feeds must be further broken down into straight feeds (has only only 1 ingredient) while compound feeds, traditionally known as rations will have a variety of ingredients

[32]. The more concentrate which is fed to the animals the less chemical Phosphate can be bought due to the increased level in the organic manure on the farm [33].

This page will show if the farmer can import or needs to export organic fertilizers (This is fertilizer which ranges from fresh/dried and animal by products [29]).This section will also show a recommended limit and a legal limit on how much fertilizer they can purchase from their local merchant. The stocking rate will be shown at the bottom of the page. This needs to be below 170 KG/N/Hectare (legal limit).

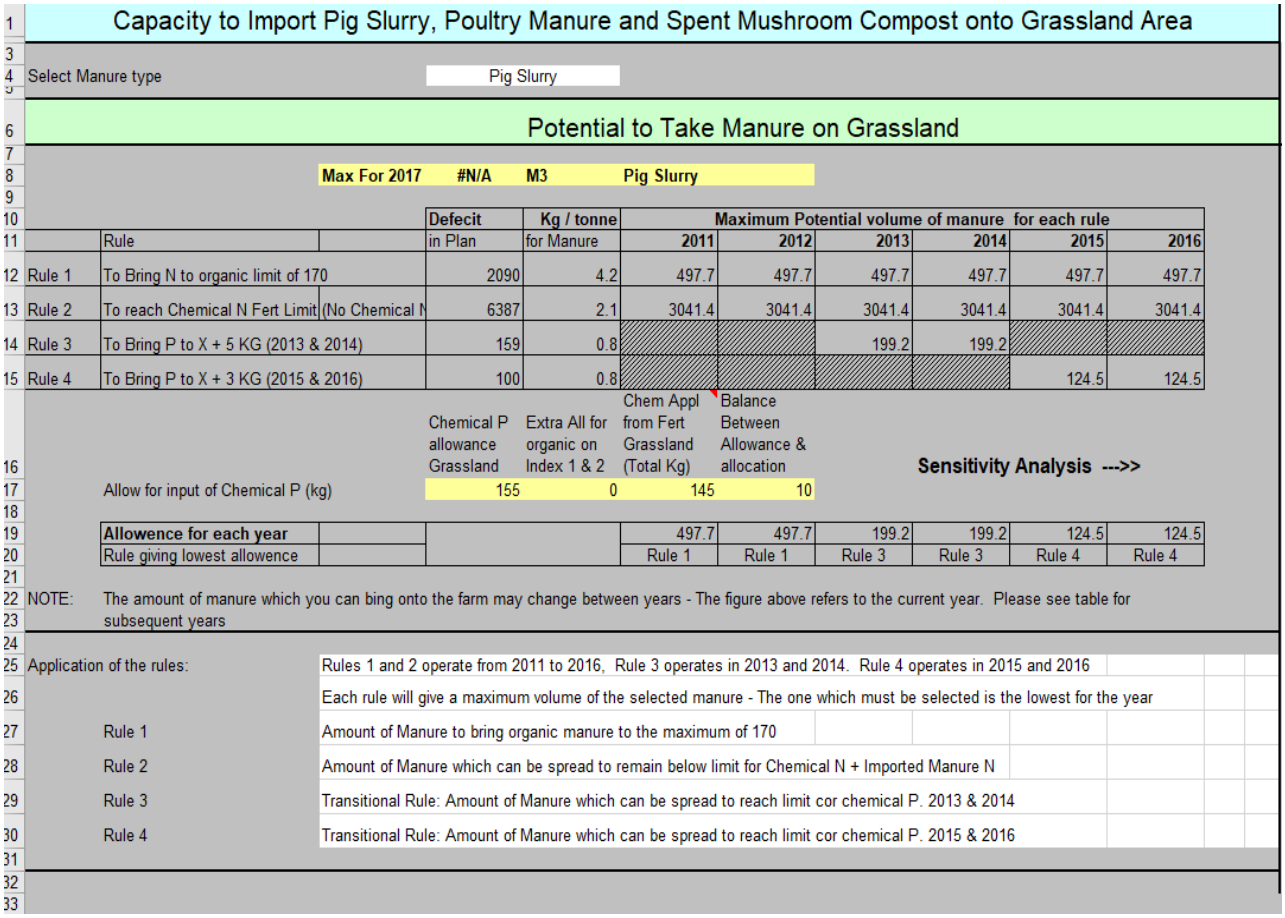
This section will also take into consideration if the farmer is in the AEOS (Agricultural Environmental Options Scheme). This is a scheme which promotes a reduction in fertilizer [34]. This section will conduct a separate fertilizer plan for these areas.

If the farmer has already or wished to import/ export organic manure it will be filled into this section. The stocking rate figure will then alter to reflect this **FIG [A] [2].**

This page will generate a stocking rate, but if the farmer is getting close to 170 Kg Nitrogen per Hectare a recommendation will appear for the farmer to consider going into derogation. The decision will remain with the farmer. If the farmer decides he does not want to apply for this then the farmer and the advisor will discuss options to reduce this rate- selling livestock, renting additional land, exporting organic manure.

3.2 Transitional rule:

This will show how much of pig slurry, compost or poultry manure can be imported into the farm while staying under 170 kg/n/ha without overspreading on any element **FIG [B] [2]**.



Capacity to Import Pig Slurry, Poultry Manure and Spent Mushroom Compost onto Grassland Area

Select Manure type: Pig Slurry

Potential to Take Manure on Grassland

Max For 2017 **#N/A** **M3** **Pig Slurry**

	Rule		Deficit in Plan	Kg / tonne for Manure	Maximum Potential volume of manure for each rule 2011	2012	2013	2014	2015	2016
Rule 1	To Bring N to organic limit of 170		2090	4.2	497.7	497.7	497.7	497.7	497.7	497.7
Rule 2	To reach Chemical N Fert Limit	(No Chemical N	6387	2.1	3041.4	3041.4	3041.4	3041.4	3041.4	3041.4
Rule 3	To Bring P to X + 5 KG (2013 & 2014)		159	0.8			199.2	199.2		
Rule 4	To Bring P to X + 3 KG (2015 & 2016)		100	0.8					124.5	124.5

	Chemical P allowance Grassland	Extra All for organic on Index 1 & 2	Chem Appl from Fert Grassland (Total Kg)	Balance Between Allowance & allocation
Allow for input of Chemical P (kg)	155	0	145	10

Sensitivity Analysis --->>

	2011	2012	2013	2014	2015	2016
Allowence for each year	497.7	497.7	199.2	199.2	124.5	124.5
Rule giving lowest allowence	Rule 1	Rule 1	Rule 3	Rule 3	Rule 4	Rule 4

NOTE: The amount of manure which you can bing onto the farm may change between years - The figure above refers to the current year. Please see table for subsequent years

Application of the rules:

Rules 1 and 2 operate from 2011 to 2016, Rule 3 operates in 2013 and 2014. Rule 4 operates in 2015 and 2016

Each rule will give a maximum volume of the selected manure - The one which must be selected is the lowest for the year

- Rule 1: Amount of Manure to bring organic manure to the maximum of 170
- Rule 2: Amount of Manure which can be spread to remain below limit for Chemical N + Imported Manure N
- Rule 3: Transitional Rule: Amount of Manure which can be spread to reach limit cor chemical P. 2013 & 2014
- Rule 4: Transitional Rule: Amount of Manure which can be spread to reach limit cor chemical P. 2015 & 2016

FIG [B] [2]

3.3 Monthly livestock calculator:

The cattle numbers can be taken directly from the Departments of Agriculture web page. An account with login details is necessary to obtain this information. All other animals the farmer will need to give monthly details. This will generate an organic Nitrate and Phosphate figure again **FIG [C] [2]**.

Stocking Rate Calculator For Planning Year

Farmer Name: 0

A **N&P from DAFF Statement**

From Jan to end of

2017

N	
P	

Mainly Drystock

B **Planned/Average Livestock Numbers January to December**

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Average
Dairy Cow		0	0	0	0	0	0	0	0	0	0	0	0.0
Suckler Cow		0	0	0	0	0	0	0	0	0	0	0	0.0
>2 Cattle		0	0	0	0	0	0	0	0	0	0	0	0.0
1-2 Cattle		0	0	0	0	0	0	0	0	0	0	0	0.0
0-1 Cattle		0	0	0	0	0	0	0	0	0	0	0	0.0
Mountain ewe		0	0	0	0	0	0	0	0	0	0	0	0.0
Lowland ewe		0	0	0	0	0	0	0	0	0	0	0	0.0
Mountain Hogget		0	0	0	0	0	0	0	0	0	0	0	0.0
Lowland Hogget		0	0	0	0	0	0	0	0	0	0	0	0.0
Horse >3		0	0	0	0	0	0	0	0	0	0	0	0.0
Horse 2yr		0	0	0	0	0	0	0	0	0	0	0	0.0
Horse 1yr		0	0	0	0	0	0	0	0	0	0	0	0.0
Foal		0	0	0	0	0	0	0	0	0	0	0	0.0
Donkey / Pony		0	0	0	0	0	0	0	0	0	0	0	0.0

Note on Usage of Table

1. Use Stocking rate report from DAFF only where stock levels are expected to be the same as in previous year
2. Figures from Planned Average LU are used for the remainder of the year
3. When entering value into Planned / Average Table all values to the right of the input cell will be updated
4. All Non Bovines must be entered for all momths in Planned / Average Table

FIG [C] [2]

3.4 Tillage:

Filling in this page is only necessary if the farmer sows tillage (this is the sowing and harvesting of crops- mainly cereal crops other than grass [35]).

This page will take into consideration the land area which is in grass and tillage. If the farmer has a mixture of both (tillage and grassland) the Nitrogen and Phosphorus figures will be taken from the grassland page. Each tillage field will be broken down into the following:

- Field identifier- name/location/ number
- Area in hectare(s)
- Crop
- Yield for additional allocation of Nitrogen and Phosphorus
- Manure type- slurry/ farmyard manure
    - Available Nitrogen
    - Available Phosphorus
    - Available Potassium -the application of Potassium in limiting in tillage not as much in grassland
- Rate of application per hectare
- Nitrogen Index
    - Chemical Nitrogen allowed- how much?
- Soil sample present
- Phosphorus index
- pH (how acidic or basic something is [41]) greater than 7 (neutral [41])
    - Chemical Phosphorus allowed- how much?
- Potassium index
    - Recommended Potassium
        - If straw is ploughed back into soil this recommendation is halved [36]

FIG [D] [2]

Teagasc
Agriculture and Food Development Authority

Fertiliser (Tillage)

Page 1

Year **2017**

Total Tillage Area	0.00	ha		Include set aside area.
Total area assigned to tillage crops	0.00	ha		
Remaining area to be assigned	0.00	ha		

Manure Imports From grassland

	Volume (t)	Designated (t)	Remainder (t)
0	0	0	0
0	0	0	0

Other manure imports

	0	0	0
0	0	0	0

Organic N	Total	Available	
Organic N Applied	0	0	kg

Organic P	Total	Available	
Organic P Applied	0	0	kg

Data Input / **Manure Application**

Field	Area (ha)	Crop	Yield for Extra N and P	Manure Type	Avail. N (kg/t)	Avail P (kg/t)	Avail K (kg/t)	Rate (t/ha)	N Index	Fertiliser N allowed (kg / ha)	Soil Sample y/n	P Index	pH>7	Fertiliser P allowed (kg / ha)	K Index	Fertiliser K* recommended (kg / ha)
										0			No	0.0		0
										0			No	0.0		0
										0			No	0.0		0
										0			No	0.0		0
										0			No	0.0		0
										0			No	0.0		0
										0			No	0.0		0
										0			No	0.0		0
										0			No	0.0		0
										0			No	0.0		0
										0			No	0.0		0
										0			No	0.0		0
										0			No	0.0		0
										0			No	0.0		0
										0			No	0.0		0
										0			No	0.0		0
										0			No	0.0		0
										0			No	0.0		0
										0			No	0.0		0
										0			No	0.0		0
										0			No	0.0		0
										0			No	0.0		0
										0			No	0.0		0
										0			No	0.0		0
										0			No	0.0		0
										0			No	0.0		0
										0			No	0.0		0

Total Fertiliser N, P and K allowed for tillage crops 0 kg N 0 kg P 0 kg K

* K recommendation should be reduced by 50% where straw is incorporated

FIG [D] [2]

3.5 Fertilizer Grassland

This is where a fertilizer plan is conducted for the farmer. This will take organic Nitrogen and Phosphorus from the grassland page. There will be a recommended limit and legal limit of both elements. The fertilizer type will be broken up into the percentage of Nitrogen, Potassium and Phosphorus. This will provide the farmer with the tonnage of fertilizer he can buy without exceeding his limits. This is particularly useful if the farmer is using multiple fertilizers **FIG [E] [2]**.

Fertiliser Options for the Grassland Area on Your Farm

Name _____ Date _____

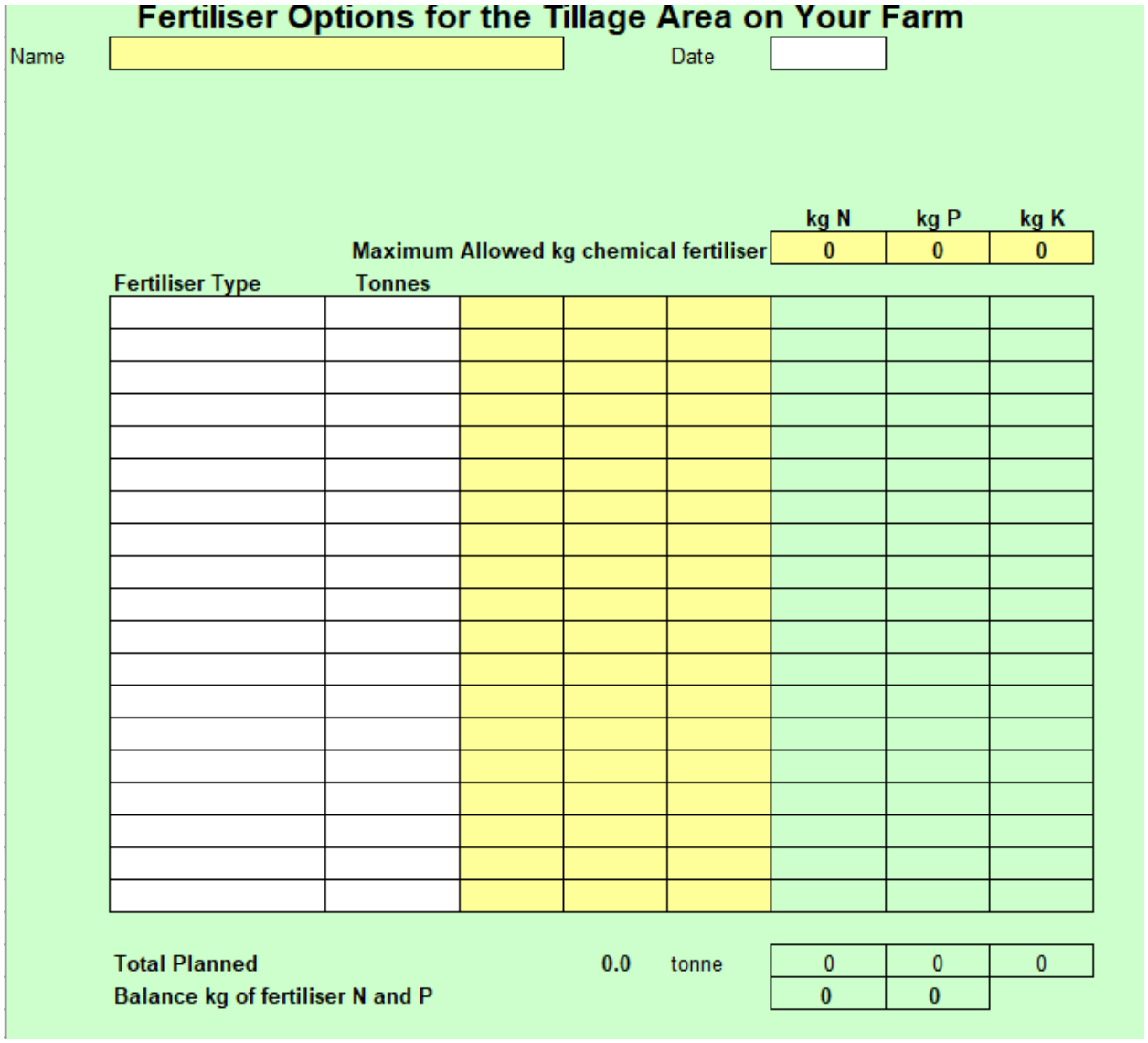
					kg N	kg P	kg K
				Maximum Allowed kg chemical fertiliser	6387	155	
				Recommended fertiliser for current Stocking rate	1874	-78	0
Fertiliser Type	**Tonnes**	**N%**	**P%**	**K%**			
18-6-12	2.0	18	6	12	360	120	240
Pasture Sward	1.0	27	2.5	5	270	25	50
Total Planned Tonnes				3 tonne	630	145	290
Balance kg of fertiliser N and P under maximum					5757	10	
Balance kg of fert. N and P under recommended					1244	-223	-290

Minus red figures indicate nutrient over the maximum or over the recommended amount

FIG [E] [2]

3.6 Fertilizer Tillage

This page is laid out and has the same components as the fertilizer grassland. If the farmer has both enterprises he will use both fertilizer grassland and fertilizer tillage **FIG [F] [2]**.



Fertiliser Options for the Tillage Area on Your Farm

Name _____ Date _____

					kg N	kg P	kg K
				Maximum Allowed kg chemical fertiliser	0	0	0
Fertiliser Type	Tonnes						
Total Planned			0.0	tonne	0	0	0
Balance kg of fertiliser N and P					0	0	

FIG [F] [2]

3.7 Slurry Storage

This page will take into consideration each storage tank which is present on the farm- both farm yard manure and slurry. The holding capacity will also be calculated (length x width x depth) the freeboard (0.2 meters [71]) (this is a safety feature which applies to both covered and uncovered tanks [37]) this must be deducted before the calculation of capacity begins **FIG [G] [2].**

There is additional factors which the advisor must take into consideration when calculating storage capacity of tank:

1. The rainfall per week **FIG [H] [26].**
2. Storage requirement per county**:**
    - 16 weeks in Carlow, Cork, Dublin, Kildare, Kilkenny, , Laois, Offaly, Tipperary, Waterford, Wexford and Wicklow
    - 18 weeks in Clare, Galway, Kerry, Limerick, Longford, Louth, Mayo, Meath, Roscommon, Sligo and Westmeath
    - 20 weeks in Donegal and Leitrim
    - 22 weeks in Cavan and Monahon

If 20% or more of the farm is in one or more counties where there is a higher storage capacity then the entire farm will fall into the higher storage category [38].

This page will show whether or not the farmer legally has enough storage for the winter months. The nationwide recommendation is to have 26 weeks storage [39].

If there is an abstract point for water for human consumption the location will be added to this worksheet.

The amount of tonnes of concentrates which have been fed to livestock will be added to this page **FIG [I] [2].**

Cross Compliance storage report **2017** 0

Name

Storage Facilities		Dimensions meters				Capacity	Available Capacity		Select
No.	Type	Length	Width	Depth	Adjusted Depth *	Calculated	Slurry	FYM	Type
						0.00			Slurry
						0.00			Slurry
						0.00			Slurry
						0.00			Slurry
						0.00			Slurry
						0.00			Slurry
						0.00			Slurry
						0.00			Slurry
						0.00			Slurry
						0.00			Slurry
▸ * After deducting freeboard					Total Capacity	0	0	0	
200 mm for covered tanks									
300 mm for uncovered tanks									

(Ensure freeboard is deducted before calculating capacity)

Tank	Area of uncovered storage tank plus area of other surfaces draining to tanks m^2	Millimetres of rain per week (Table of S.I. 378)	Weekly rainfall volume into storage tank m^3	Weeks storage required (16, 18, 20, 22)	Additional storage required for rainfall m^3
No.	(a)	(b)	(c)= (a) * (b) /1000	(d)	(e) = (c) * (d)
		25.00		**16.00**	
		25.00		**16.00**	
		25.00		**16.00**	
		25.00		**16.00**	
		25.00		**16.00**	
		25.00		**16.00**	
		25.00		**16.00**	
		25.00		**16.00**	
Storage required for rainfall entering tank m^3				Total	0

FIG [G][2]

County	Millimetres per week	County	Millimetres per week
Carlow	24	Longford	23
Cavan	27	Louth	20
Clare	32	Mayo	40
Cork	37	Meath	19
Donegal	38	Monaghan	23
Dublin	17	Offaly	20
Galway	34	Roscommon	26
Kerry	45	Sligo	32
Kildare	18	Tipperary	27
Kilkenny	23	Waterford	31
Laois	22	Westmeath	21
Leitrim	33	Wexford	25
Limerick	26	Wicklow	33

FIG[H] [26]

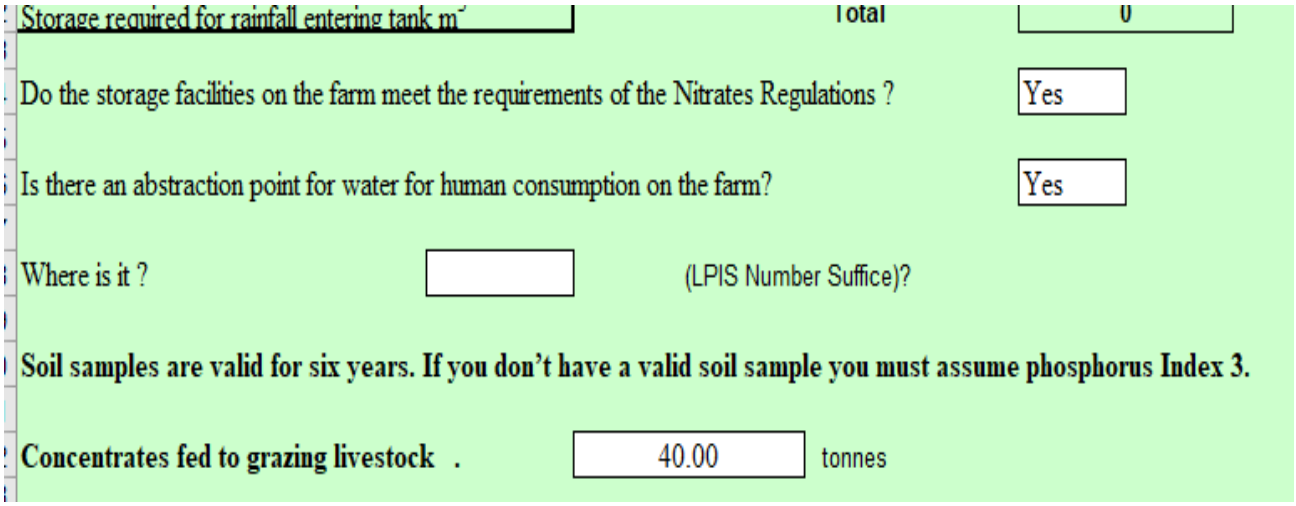


FIG [I] [2]

3.8 Fertilizer Records

This page goes into detail about the fertilizer which was used during the previous year on the farm. This page shows:

- Maximum allowed Nitrogen, Phosphorus and Potassium application
- Recommended allowed Nitrogen, Phosphorus and Potassium application
- Opening stock **FIG [J] [2]**
- Fertilizer purchased
    - Date
    - Type
    - Composition
    - Supplier
- Tonnes **FIG [K] [2]**
- Total fertilizer bought
- Fertilizer sold off farm
- Closing stock
- Balance compared to maximum allowed
- Balance compared to recommendation **FIG [L] [2].**

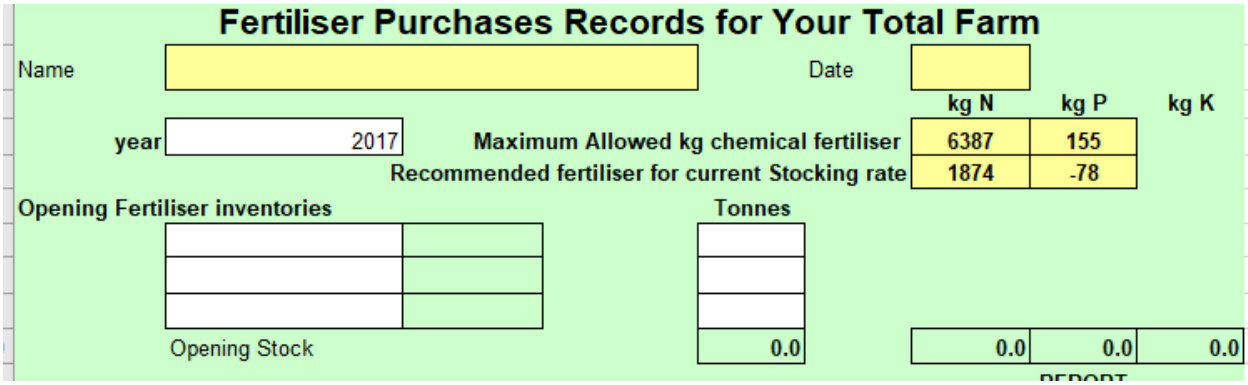
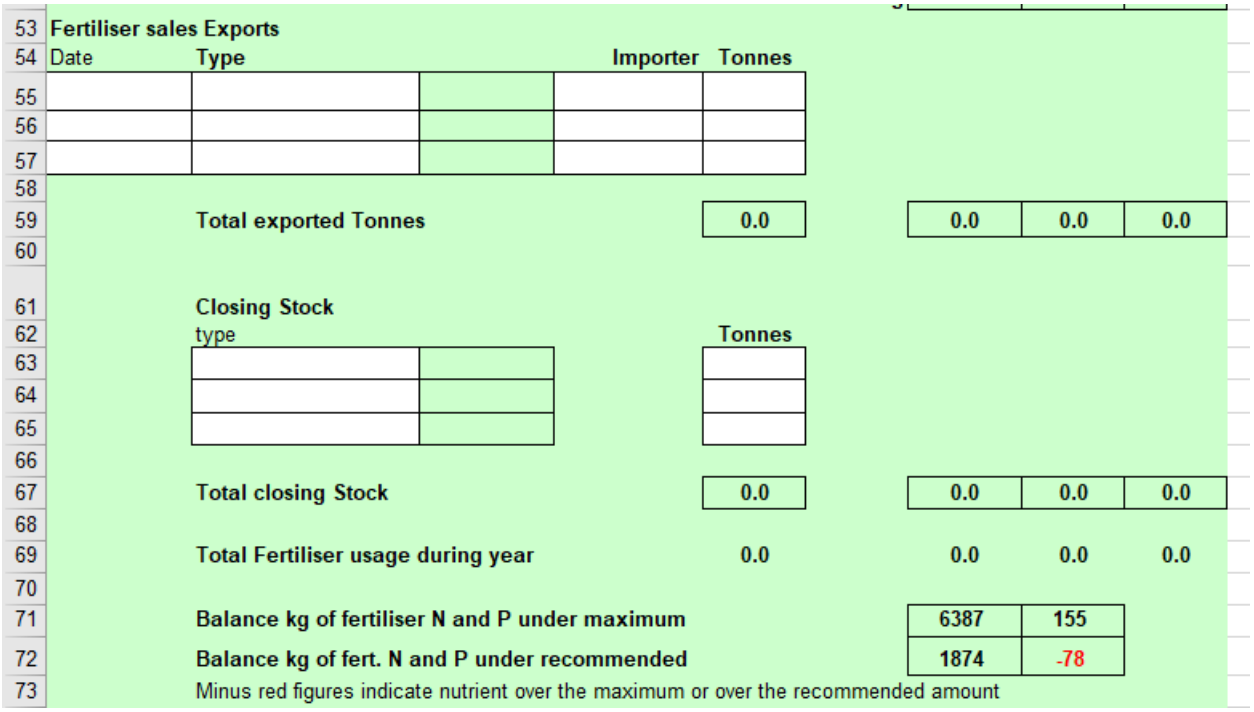


FIG [J] [2]

Fertiliser purchases/imports

Date	Type	Composition	Supplier	Tonnes
	Total Purchased Tonnes			**0.0**

FIG [K] [2]



53	**Fertiliser sales Exports**							
54	Date	**Type**			**Importer**	**Tonnes**		
55								
56								
57								
58								
59		**Total exported Tonnes**				**0.0**	**0.0**	**0.0**	**0.0**
60								
61		**Closing Stock**						
62		type				**Tonnes**		
63								
64								
65								
66								
67		**Total closing Stock**				**0.0**	**0.0**	**0.0**	**0.0**
68								
69		**Total Fertiliser usage during year**				**0.0**	**0.0**	**0.0**	**0.0**
70								
71		**Balance kg of fertiliser N and P under maximum**					**6387**	**155**
72		**Balance kg of fert. N and P under recommended**					**1874**	**-78**
73		Minus red figures indicate nutrient over the maximum or over the recommended amount						

FIG [L] [2]

3.9 Conclusion:

Microsoft Excel is a relatively easy way of answering farmer's questions quickly. After thoroughly reviewing each page I noticed some unnecessary repetition such as the fertilizer plan was on 2 separate pages. In my opinion this is an important component and should have its own section. This section is also missing a Lime requirement section- this is not anywhere in the programme. This would be a useful section to have as farmers spread lime on their fields and is often linked to soil results.

Looking at 'grassland' there is far too much information in one area and should be broken up and split across many sections, this will make each individual section smaller and confusion could be avoided.

There are 2 separate pages for fertilizer tillage and grassland which is unnecessary. As fertilizer options are the same for both enterprises the same page would suffice for both.

When slurry storage space is being calculated a huge component which is missing is how much is excreted from the animals during the specific period. As this page is not submitted anywhere the location of an abstraction point for human consumption is irrelevant.

The fact there is no printable report from this is also a negative.

4.0 The NMP Online Application

The online system which is currently in place is called NMP (Nutrient Management Planning) [3]. This application was designed for farmers who are in derogation (allows farmers to have a higher stocking rate [14] - the stocking rate will go from 170 kg Nitrogen per hectare to 250 kg Nitrogen per Hectare [15]). This Online Application The web app requires too much information from lower rate production farmers, information that most lower rate production farmers do not possess or details which prove later to be irrelevant.

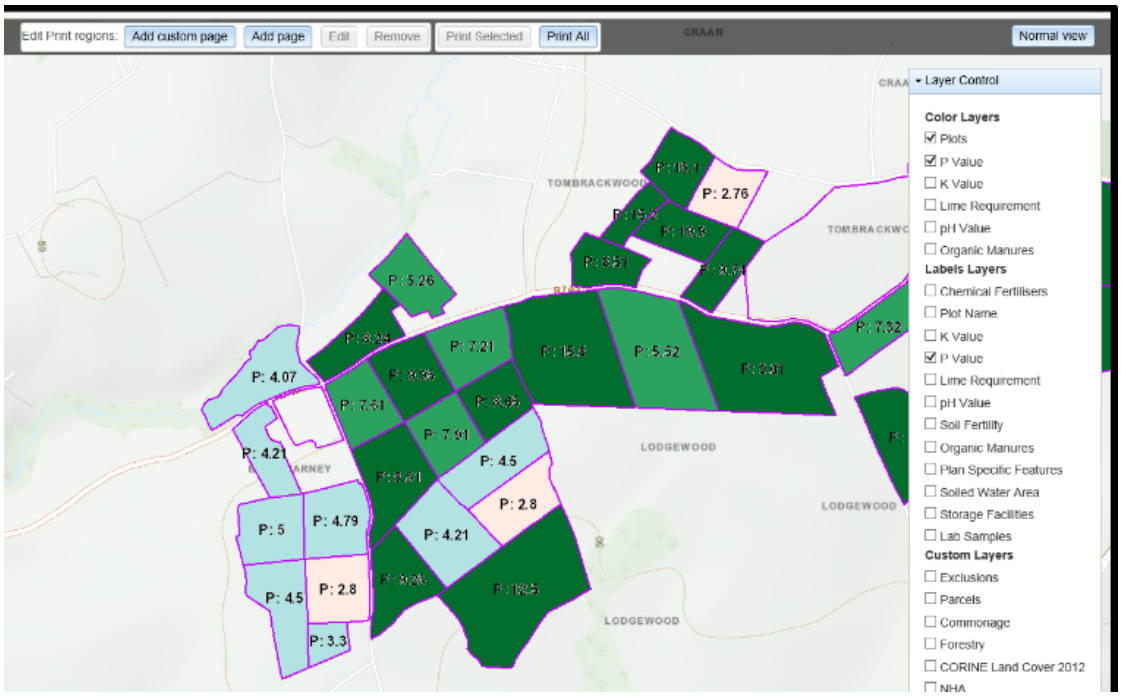
Regardless, this information is required for the current web app to function in its current state yet after production several faults were discovered, faults which proved devastating in regards to work hours and also returned a ream of paper ranging anywhere from 20 to 50 pages documenting the majority of the irrelevant data that was obtained.**Fig [M] [4]**

Fig[M][4]

4.1 NMP's current functionality includes:

- Map drawing with labelled diagrams (eg. to illustrate soil sample results) **Fig[N][5]**
- Shows grassland stocking rate
- Shows farmland stocking rate
- Shows opening and closing stock of fertilizer

- Can import soil samples
- Also contains all of the Excel functionality
- Fertiliser plan
- Liming plan



Fig[N]. [5]

4.2 Pros

- Its necessary for completing previous year derogation applications and creating new applications for the following year
- Fields are monitored on small areas
- Cost effective for fertilizer plans- made to suit farmer
- Liming plan

4.3 Cons

- Extremely time consuming to create a new application
- Very difficult to navigate
- Data can be replicated easily

- Record 5 land (total area of field is divided by the percentage of the year the land is rented) must be manually calculated
- Data has often been mistaken and wrongfully rewritten
- Reports are complex containing a lot of technical jargon
- Mapping system is difficult to work
- Returns have too much unnecessary information
- Expensive- this is an added expense to a farmers consultation fees on annual basis
- Additional farm visits required for mapping system of sheds
- Soil sample area very small (under 5 hectares)
- Can only import soil samples from a Teagasc based soil sampling lab
- Not environmentally friendly
    - Maps are not printed double sided

5.0 Overview of website NMP (Nutrient Management Planning)

5.1 Creating a new plan

When an agricultural advisor logs into the webpage he will create a plan for the farmer. For this he will need basic information off the farmer such as:

- Year
- Herd number
- County
- enterprise(s) **FIG [O] [46]**
- Soil samples
- Winter housing
- Imports
- Exports **FIG [P] [46]**

The farmer may have a profile from previous years which means most of the above data will be in the new profile but should rectify any necessary changes which have occurred in the previous year. An example of this would be a beef farmer who has bought sheep on to the land during the previous winter.

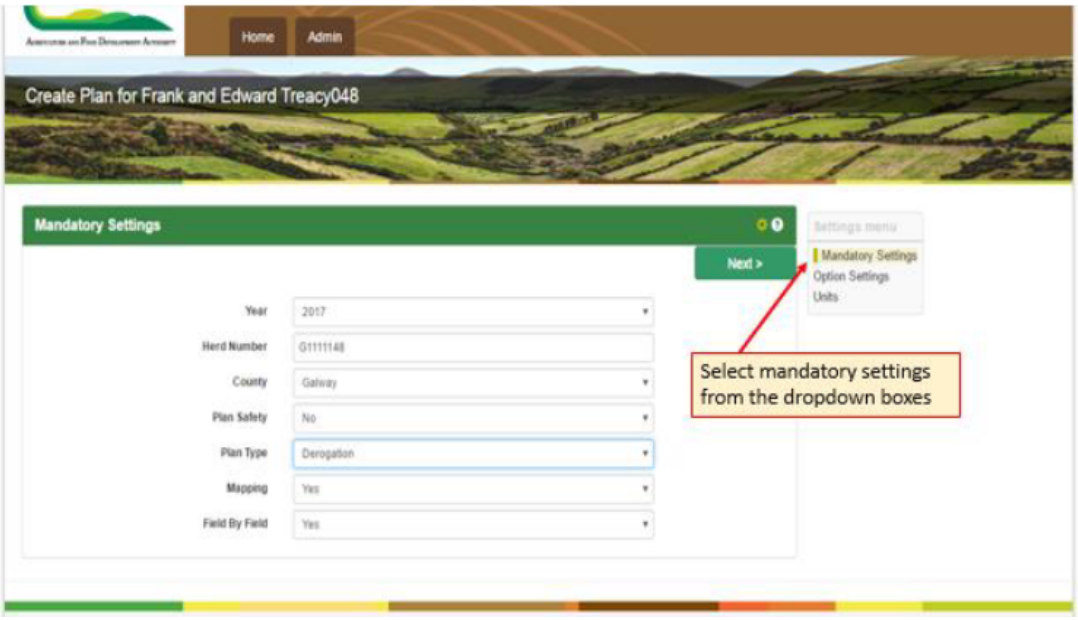


FIG [O] [46]

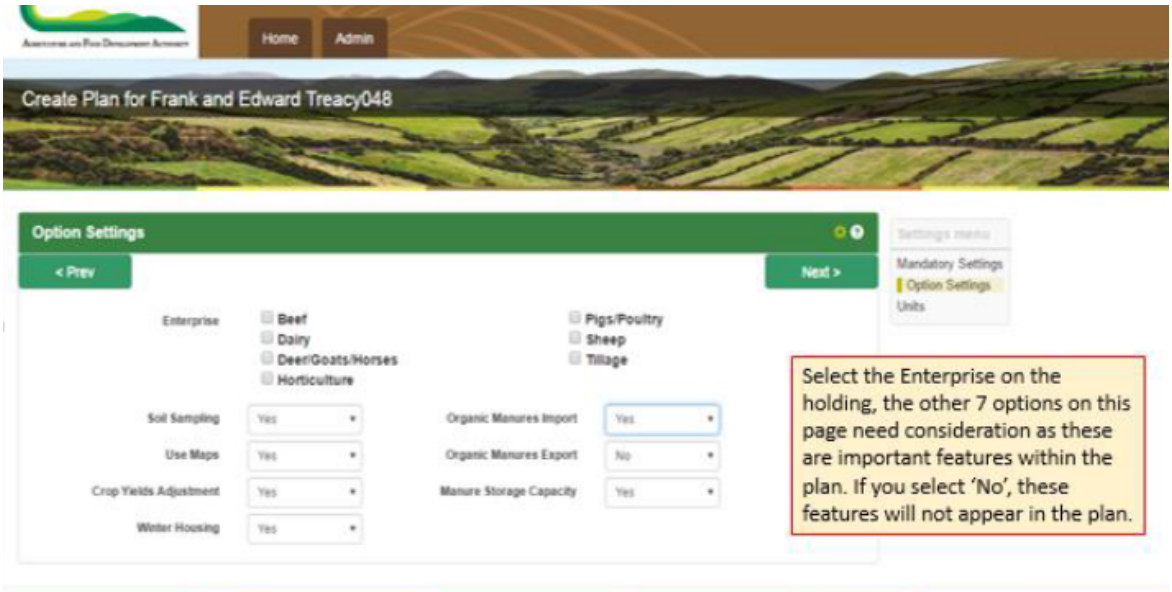


FIG [P] [46]

5.2 Soil Samples

The advisor will be brought to the soil sample page. If there was an existing plan the old samples will be automatically brought into the new plan. Each soil sample will have a colored flag beside it- this is an indication of how recent the soil sample was taken:

- Red: The soil sample is expired (soil samples are valid for 5 years) [47]. Soil samples which are in red should be deleted.
- Yellow : The sample will expire during the year.
- Orange: The soil sample will expire next year
- Green: The soil sample is still in date **FIG [Q] [46]**

The advisor will advise the farmer that he needs new soil samples for these areas.

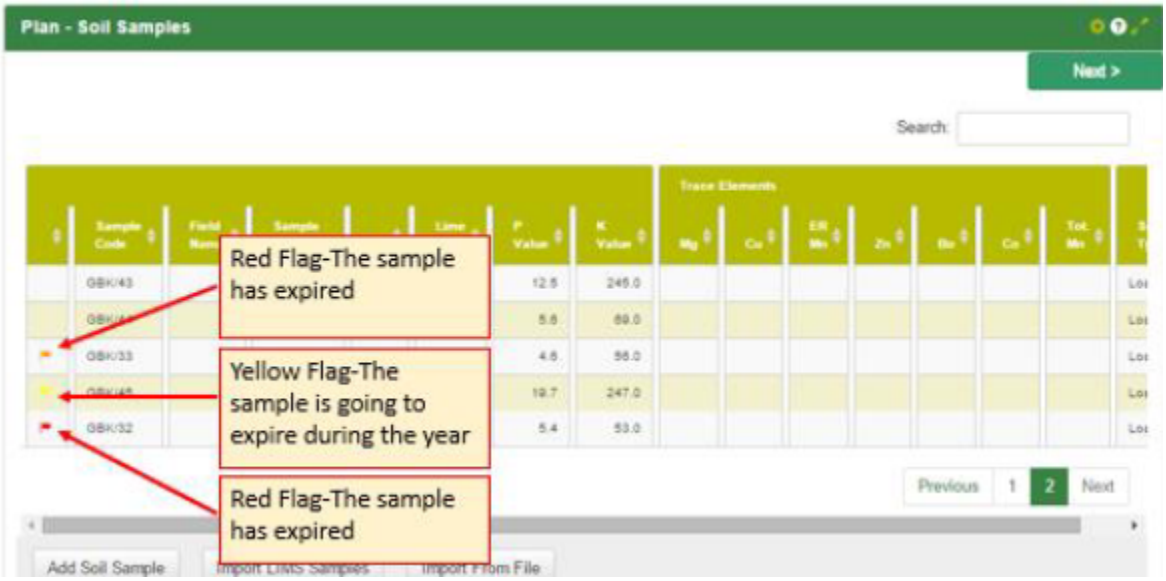


FIG [Q] [46]

The advisor will then add new soil samples if necessary. This needs to be done manually if the soil samples are not completed by a Teagasc lab. The new soil samples will then be allocated to areas of fields. Each sample needs to be inputted 1 by 1 **FIG [R] [46].**

If the soil samples were completed by a Teagasc Lab they can be imported directly. Only 1 page can be imported at once which has a maximum of 10 samples. More than 1 page can be imported. The advisor needs to be careful not to import soil samples which are already imported. The advisor needs to ensure these soil samples are correct.

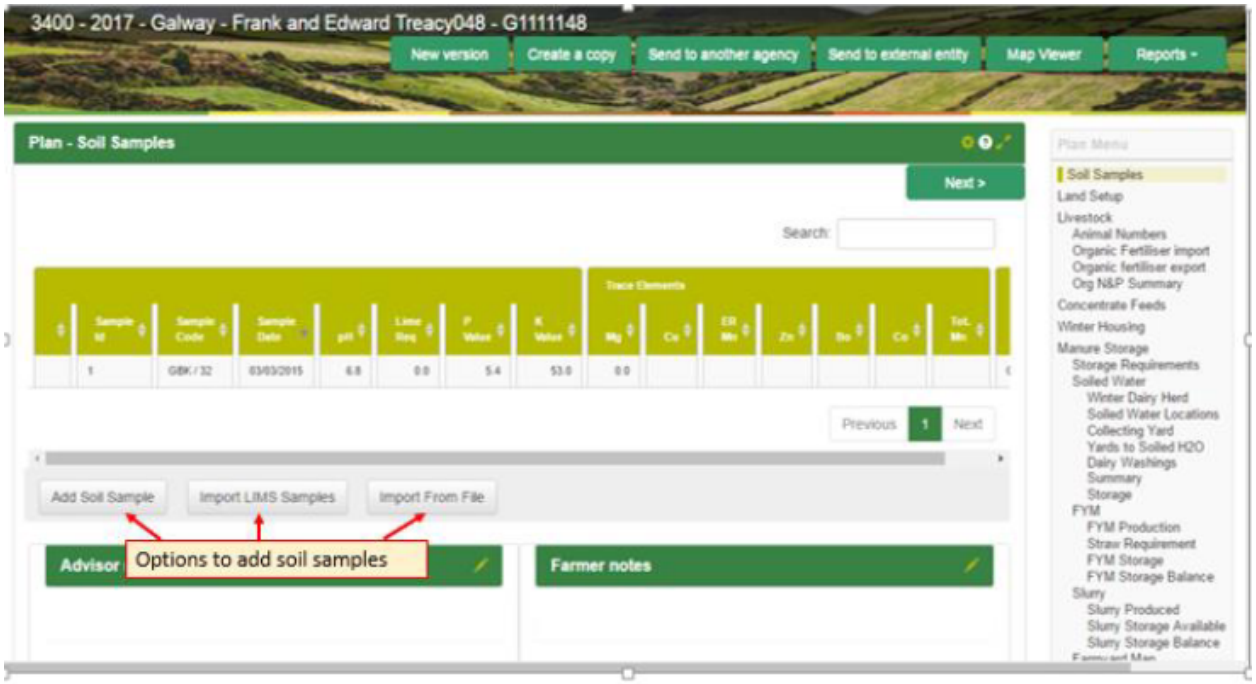


FIG [R] [46]

5.3 Land Set-up

If in the previous year the farmer has rented/ bought more land, this can be added on this page. This can be done by searching the townland in the search tab. The advisor must then pick the correct field. This can be done by identifying the LPIS number(Land Parcel Identifier System) (each field has its own individual number) [48]. **FIG [S] [46]**

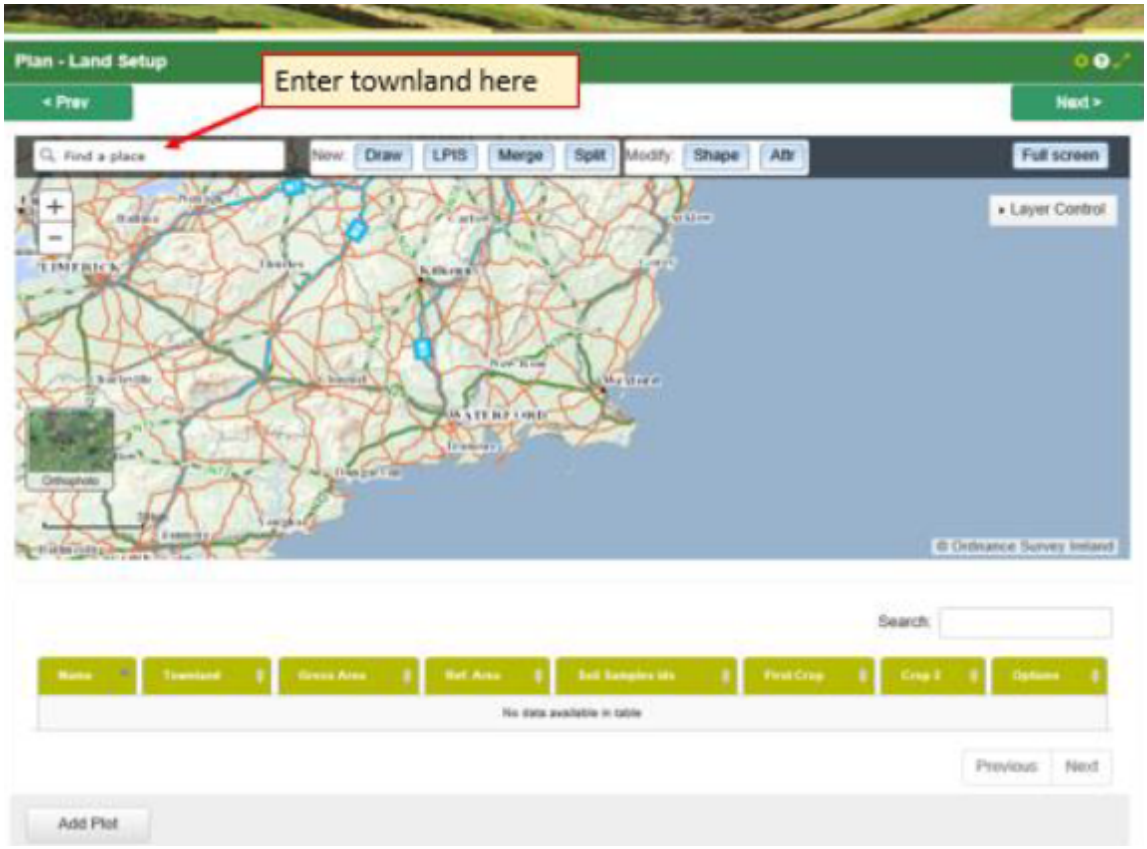


FIG [S] [46]

Once the advisor has added the new field(s) to the farmers area of land. The advisor can then divide the field into smaller sections (plots) and add the relevant soil samples **FIG [T] [46]**. In this section the advisor can also merge plots together. This can be done if plots are beside each other and share the same soil sample. This is also useful if the advisor makes a mistake and divides the land/ area wrong.

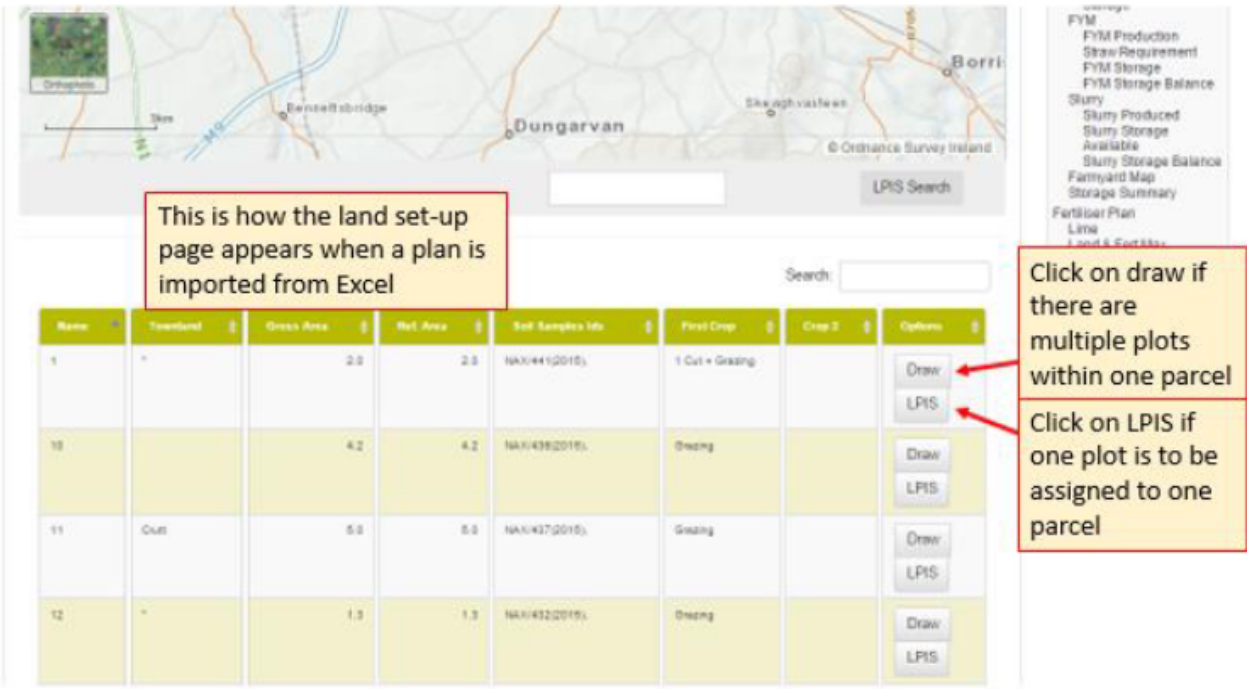


FIG [T] [46]

5.4 Livestock

This is a section which will be automatically carried over from the previous year. This should be edited to suit the farmers planned numbers for the upcoming year. Livestock will be broken down into many sub categories:

- Dairy cow
- Suckler cow
- Cattle (2 years plus)
- Cattle (1-2 years)
- Cattle (0-1 year)
- Ewes
- Lambs
- Rams
- Horses

If the farmer has added an additional type of livestock it will be added in this section. Once this is completed the webpage will generate an organic Nitrogen and Phosphorus figure.

5.5 Organic fertiliser Import

This section is only used if a farmer has imported organic fertilizer from another farm. The advisor will add the type and quantity of the manure into this section. Organic manure which can be imported is divided into 4 sections;

1. Liquid manure
    a. Cattle manure
    b. Pig manure
    c. Soiled water
2. Solid manure
    a. Dunstead manure- this has been left to decompose in the weather
    b. Farmyard manure
3. Poultry
    a. broiler / deep litter
    b. Layers (30% dry matter)
    c. Layers (55% dry matter))
    d. Turkeys
4. Mushroom compost. [49]

Each individual manure will have its own nutritional breakdown and therefore will be allowed to import various amounts depending on the farm. This page will generate the nutritional value of the import for the farmer and advisor. Generally a farmer will only import 1 type of organic manure.

This will adjust the stocking rate on the farm. The stocking rate can not go over 170 kg Nitrogen per Hectare as derogation farmers cant import organic manure [50]. Once this has been completed the organic Nitrogen and Phosphate figure will be updated.

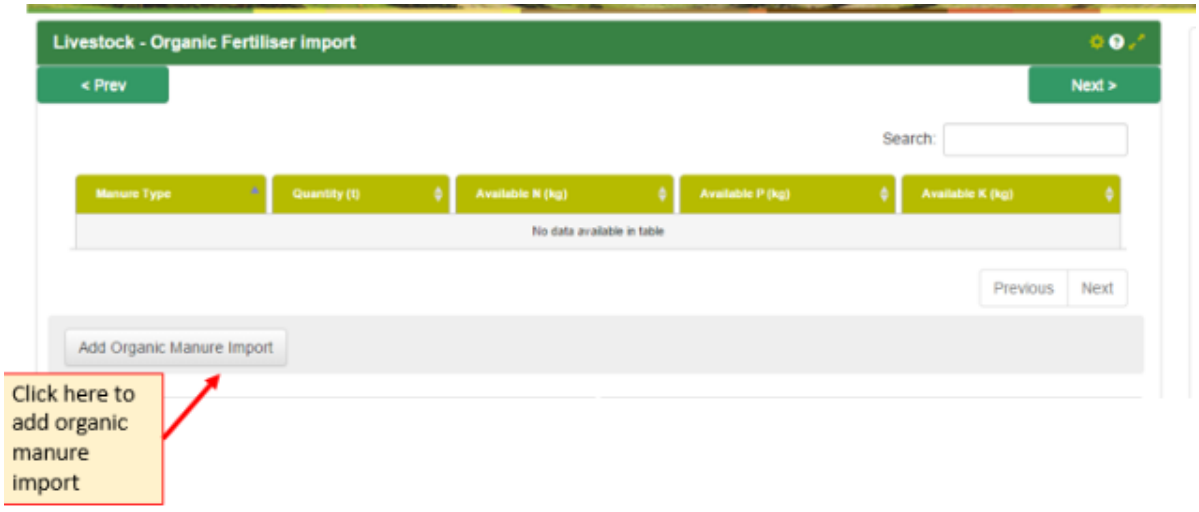


FIG [U] [46]

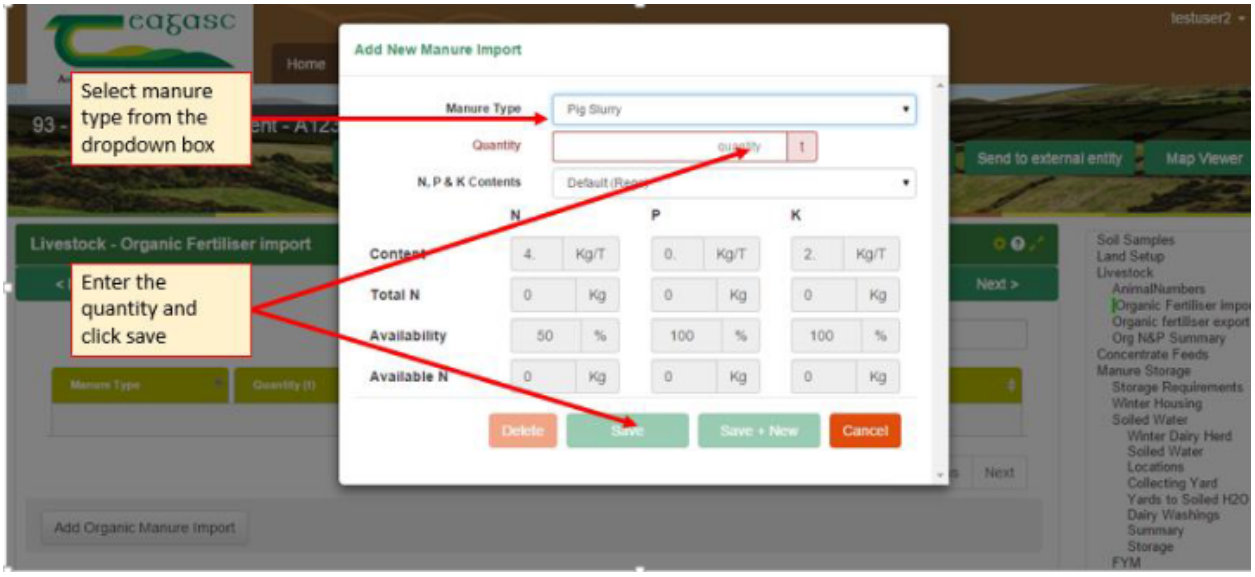


FIG [V] [46]

5.6 Organic fertiliser Export

Filing out this section is only necessary if the farmer has exported organic manure to another farmer. The advisor will add the type and quantity in which has been exported off farm. Generally farmers will export cattle slurry or farm yard manure. When this data is entered the nutritional value for the export will be shown. The stocking rate will adjust to show the export. Once this has been completed the organic Nitrogen and Nitrogen figure will be updated.

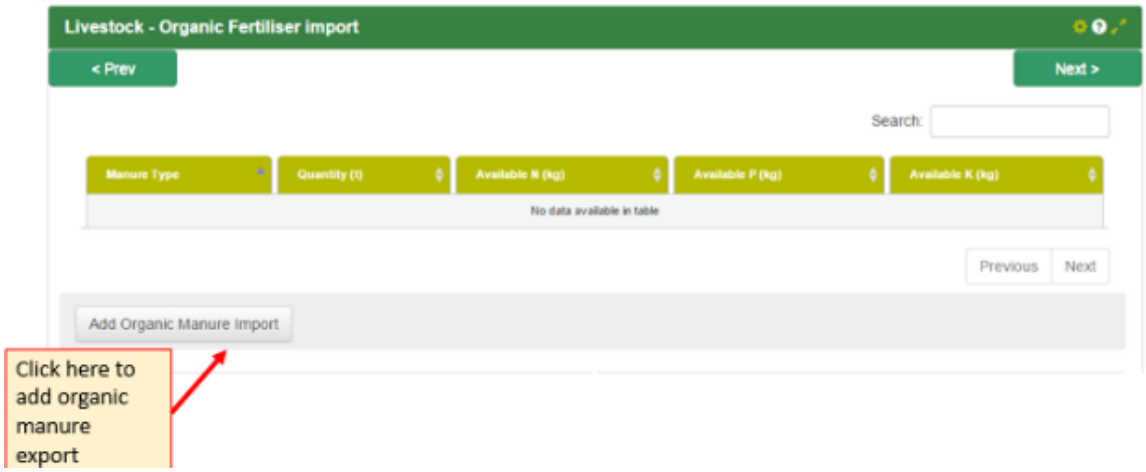


FIG [W] [46]

5.7 Organic N and P summary

This page will give a summary of the breakdown of the total Phosphates and Nitrates which is currently on farm **FIG [X] [46]**. The page will give a breakdown of what was produced on the farm and if there was an import. This is an information page only and the data shown cant be edited.

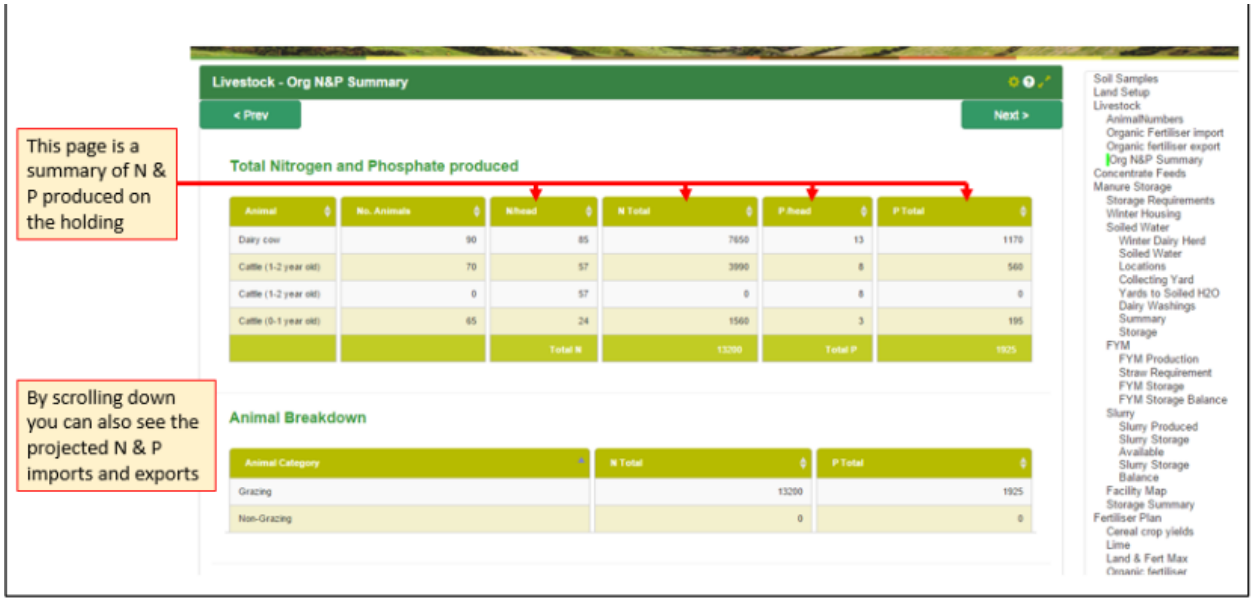


FIG [X] [46]

5.8 Concentrate feeds

This is a feedstuff which is fed with high content of nutritional substances [57].
When the total feed is inputted the feed must be broken down into straight and compound feeds. This can be done by using a drop down list. If the straight option is selected the advisor must select what straight has been fed to the animals.i.e barley/ wheat.If there is multiple straightes fed then the advisor must do this multiple times. The data entered here must be done in tonnes.This is due to the fact each feed type has a different protein level which will affect how much phosphate is excreted into the slurry. This will affect the upcoming fertiliser plan.

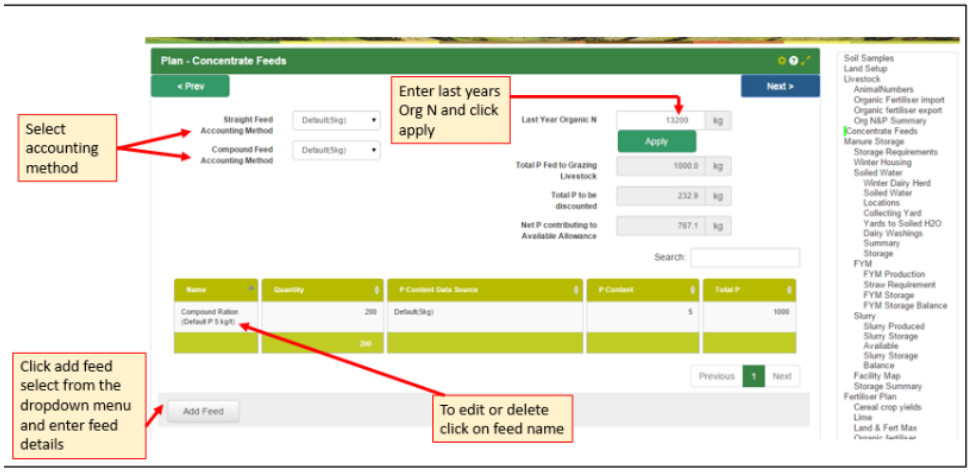


FIG [Y] [46]

5.9 Winter Housing

This section will assess to see if the farmer has enough farmyard manure/ slurry storage for the amount of animals on the farm. The animals will be broken down into various age categories **FIG [Z] [46]** and housed on what's available. This takes various factors into consideration- the county the farm is in, if the farmyard manure/ slurry is indoor/outdoor, the usage of straw(**FIG [AA] [46]** - (is straw usage is low there will be a runoff which needs to be stored, this will reduce the slurry storage capacity on the farm, if the usage is high then there will be no runoff but the amount of animals which can be housed in this area will be reduced as the maximum legal height a straw bedded shed can be is 0.65 meters) .

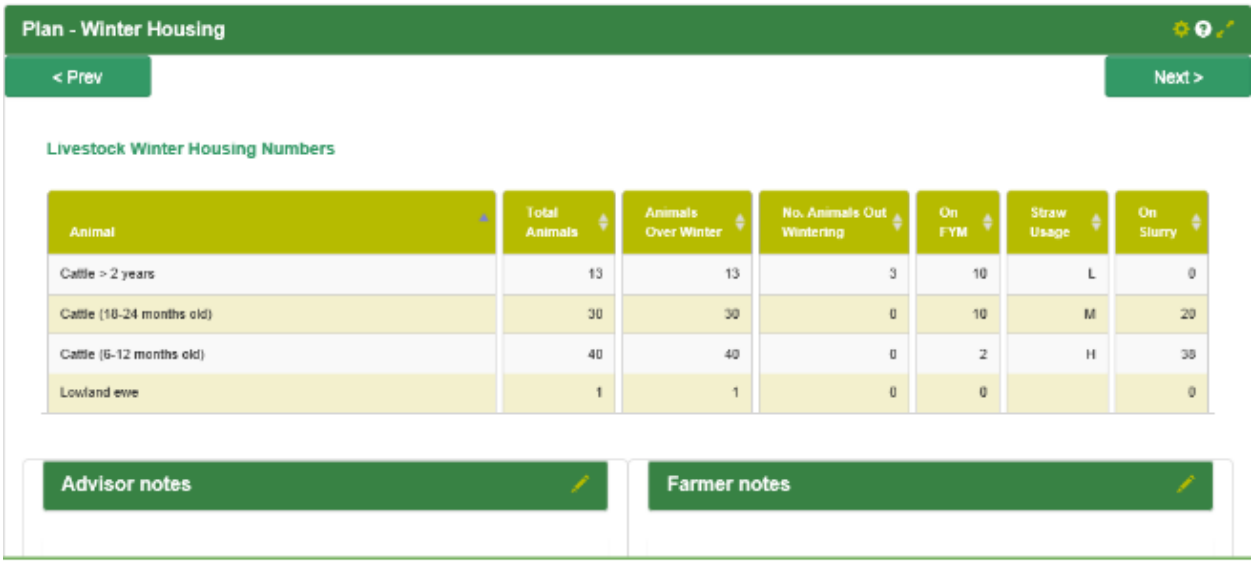


FIG [Z] [46]

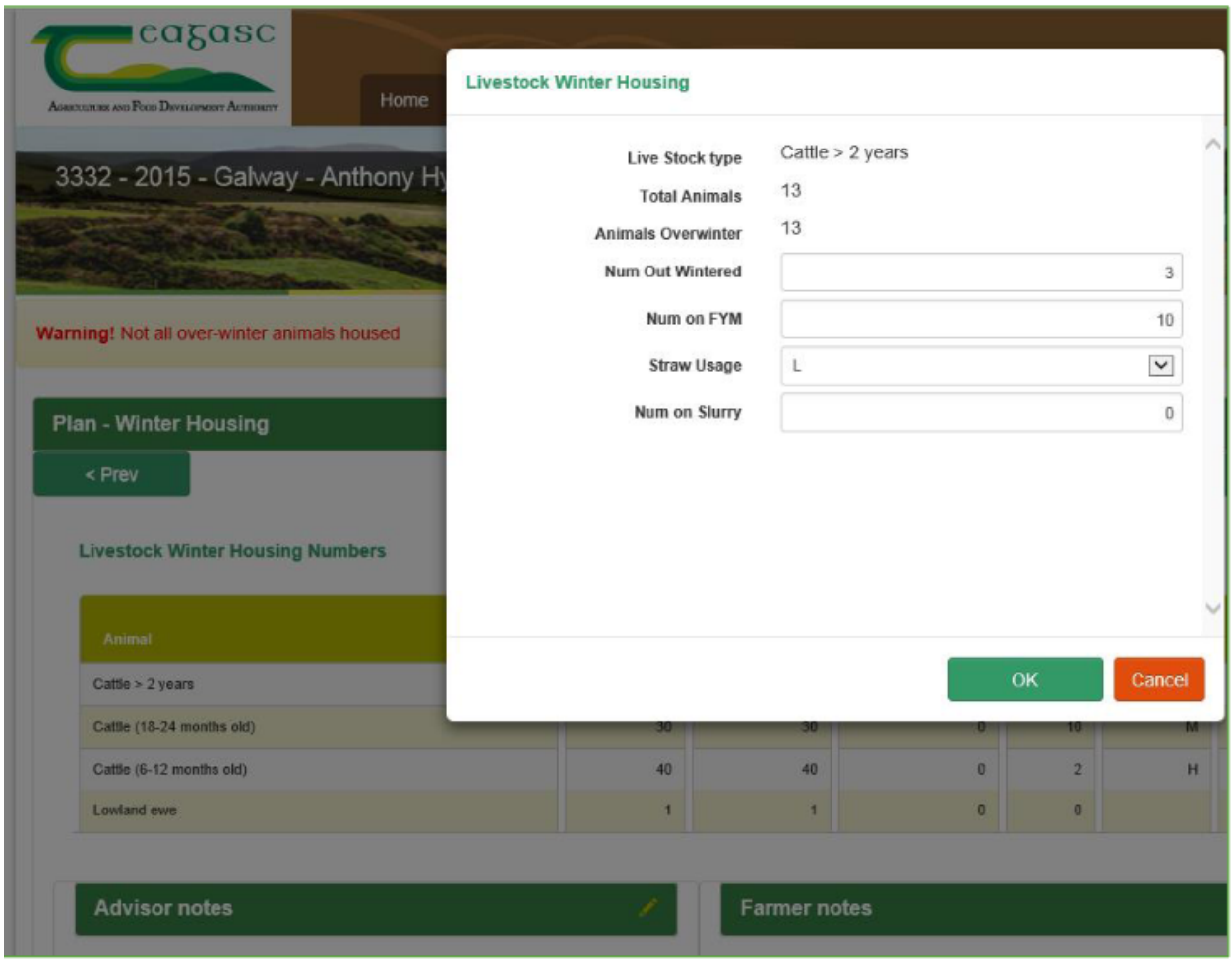


FIG [AA] [46]

5.10Manure Storage

5.10.1 Storage Requirements

This is viewing if the farmer has legally enough slurry storage or not. This will take county and rainfall into consideration when the calculations are being done. If the farmer wants to add additional weeks this can be adjusted in the custom weeks storage. If the farmer is zero grazing(the farmer will mechanically mow the grass and bring it to the cattle while they are still indoors [58]) then this can be set for 52 weeks if he chooses to do so.

If a farmer has storage in various counties and more than 20% is in various zones [23], **FIG [AB] [46]** the zone with the longest storage facility must be selected.

In recent years there has been a slight adjustment made to the requirements of dirty washing storage legal requirements.If a purpose built dairy washings tank has been built before 1st January 2015 they only needed to have 10 days storage but if this has been built after this date there is now a requirement for 15 days storage.

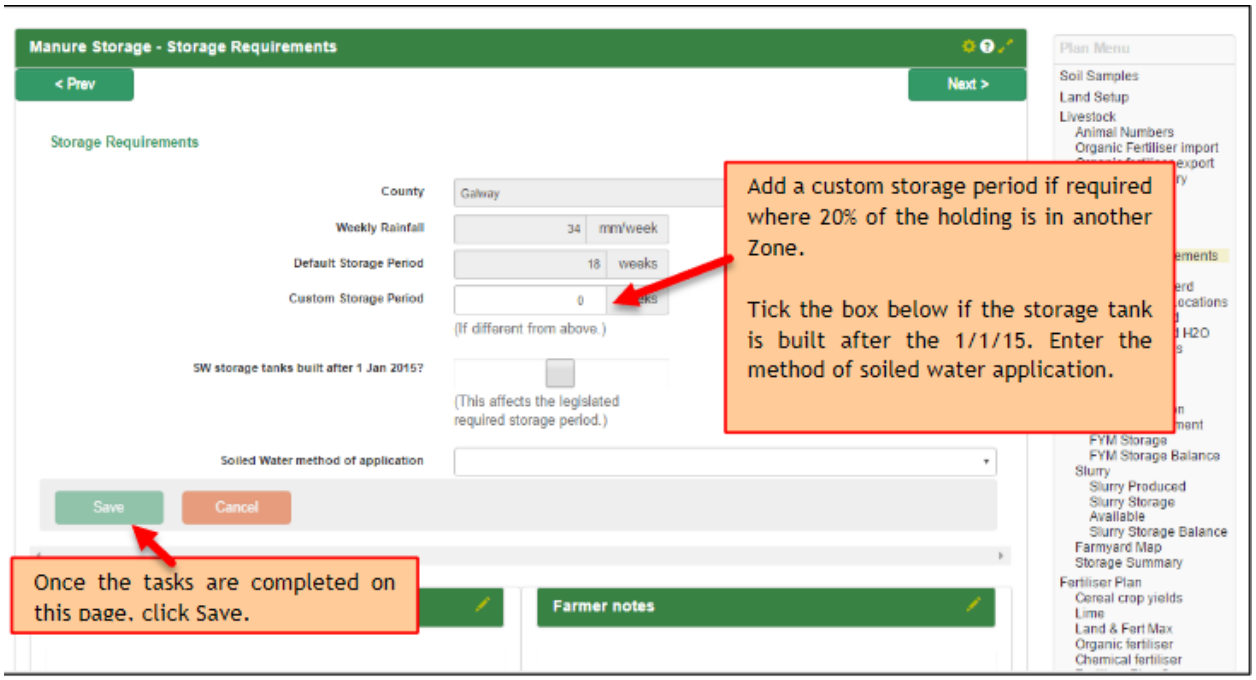


FIG [AB] [46]

5.11 Soiled water

Dairy soiled water is water from concreted areas, hard stand areas and holding areas for livestock. that has become contaminated by livestock faeces or urine, chemical fertilisers and parlour washings [59].

5.11.1 Winter Diary Herd

The average number of dairy cows milked during the winter months will be added into this section. If there is a dy period (this is a 60 day rest period between one lactation to the next [60]) then the final date of milking (Autumn) and first date of milking (spring) will be entered **FIG [AC] [46].**

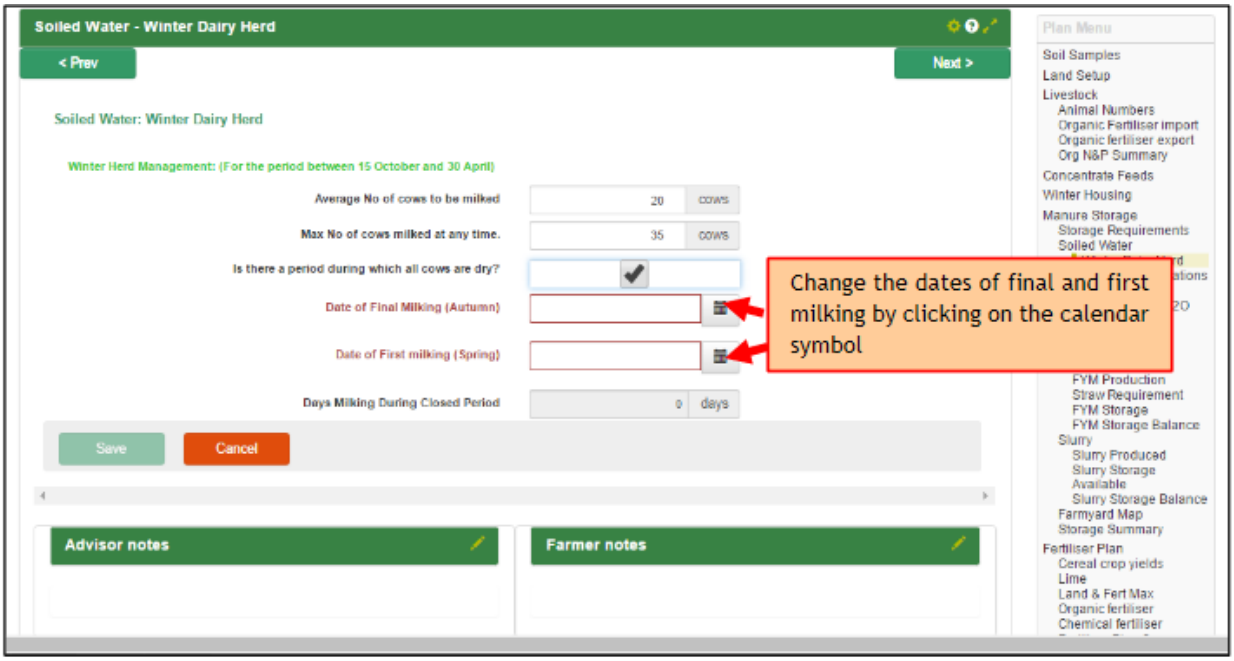


FIG [AC] [46]

5.11.2 Soiled Water Locations

The farmer must state what dirty areas he has on the farm as the run off from these sections must be collected and stored. If these areas are not covered then rainfall must be also collected and stored. This would include collecting yards, milking parlour, handling areas etc **FIG [AD] [46].**
In this section the advisor must state if the dirty/ soiled water is stored with slurry or if it has its own purpose built tank. If the dirty/ soiled water is stored with slurry it will then be classified as slurry.
If there is a purpose built tank for dirty/soiled water then there is only a holding period of 10/15 days depending on when the tank was built **FIG [AB] [46].**

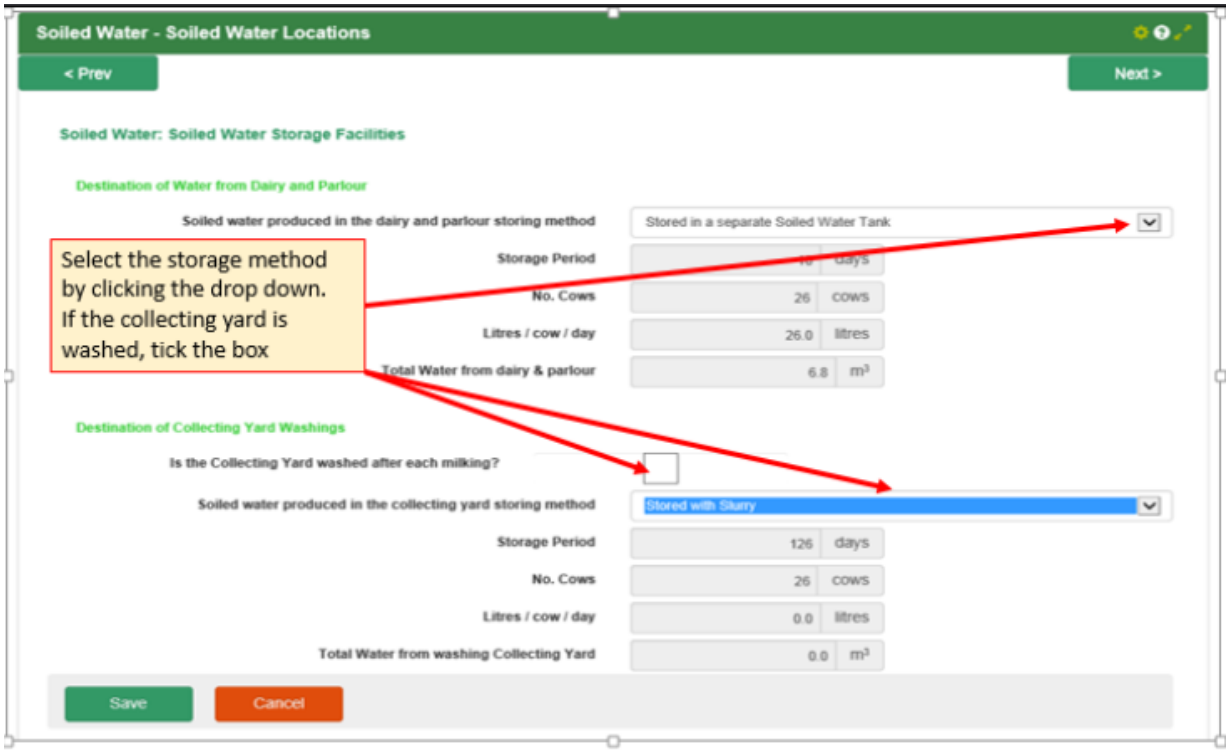


FIG [AD] [46]

5.11.3 Collecting yard

This should be added into the soiled water area. It is very important that each area entered is given a clean and unique label i.e. Yard 1. When inputting this in it is vital that advisor has all relevant information such as:

- Shape of yard
- Length
- Width **FIG [AE] [46]**

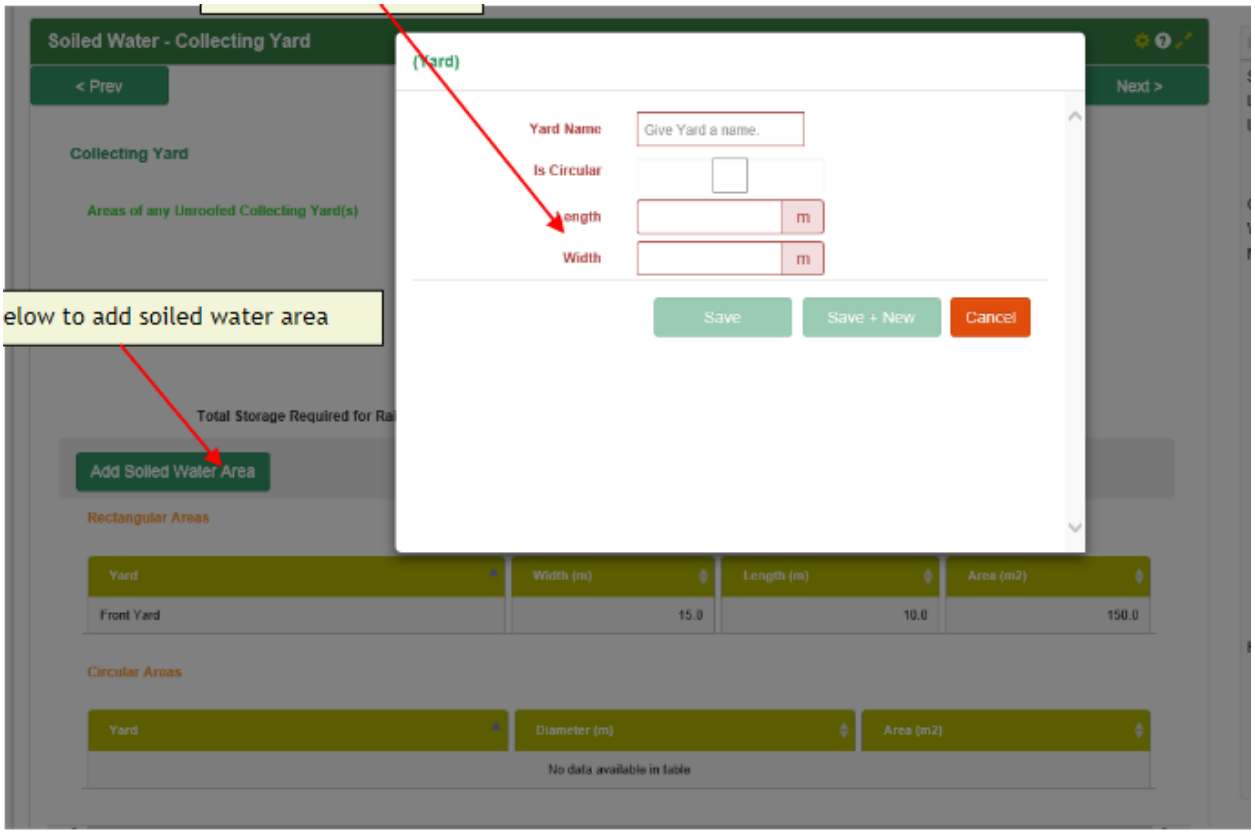


FIG [AE] [46]

5.11.4 Storage

This page will show the amount of dirty/ soil water which is produced on the farm. If the farmer has purpose built tanks NMP will automatically if there is enough dirty/soil storage facilities on the farm.

5.12 Yard Manure

5.12.1 Farm Yard Manure Production

This page will be a pre-populated page. The data which is viewed here is generated from the date put in the winter housing page. An advisor can not edit any of the data which is shown here.

5.12.2 Straw requirement

This page will be very useful and beneficial to farmers. This will inform the farmer the minimum amount of bales of straw he will require for bedding the cattle for the upcoming winter. This is a drop down section with the various sizes of straw bales:

- 4 x4 meters
- 5x4 meters
- 8x4x3 meters
- 8x4x4 meters
- Small square bales [62]

5.12.3 FarmYard Manure Storage

This will be a drop down section and the advisor must state if the shed is the following **FIG [AF] [46]**:

- Under animals; this applies to a loose shed which animals are using
- Covered; this is a large roofed Farm yard manure store where no animals are housed. The height of this will be much greater than what would be under animals. When naming the sheds it's important that the shed gets a unique name.

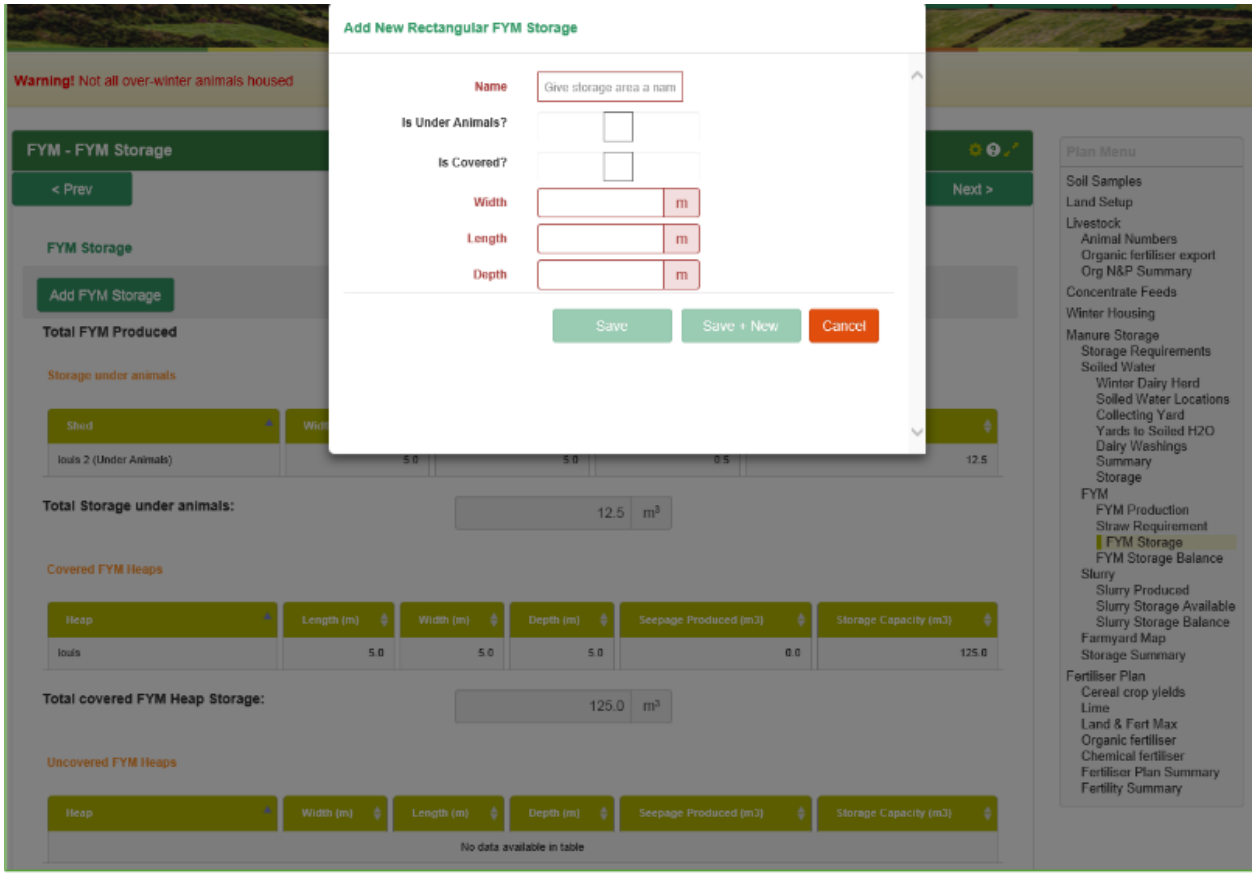


FIG [AF] [46]

5.12.4 FarmYard Manure Storage

This page is an information page only and the data cant be edited. This is a summary page which gives the following data:

- Seepage produced
- Farm yard manure produced
- Farm manure storage available
- Farm yard manure storage balance

5.13 Slurry

5.13.1 Slurry Produced

Slurry storage required on farm is pre populated and comes from various areas which have been previously filled in:

- Animal slurry produced
- Seepage from farm yard manure (if necessary)
- Dirty water on the farm if this is stored with slurry.

5.13.2 Slurry Storage Available

This page allows the advisor to add the various slurry storage areas with their own unique name. There is various types of slurry storage:

- Covered
- Uncovered- this will reduce the amount of slurry which can be stored in the tank due to taking in rainfall also.
- Lagoon (this is a large circular slurry pit with a concrete storage to hold large amount of slurry [63])

5.13.3 Slurry storage Balance

This is a summary page which has pre populated data. This page will give a summary of the following:

- Slurry produced
- Storage available
- Storage balance

5.14 Farm Yard Map

The map should be zoomed in to locate the farm. When the farm yard has been located all the above sheds will now be marked as unmapped facilities.
The advisor will right click on each shed/ tank and bring it to the correct location. This is why each shed gets its own unique name as this will make mapping easier. A shed or map cant be deleted in this section but can be done so in its original input section. Features such as trees and walls can also be added.

5.15 Storage Summary

This is a total summary page for farm yard manure, slurry and soiled water storage capacity. This is a summary page only and the data can not be edited.

5.16 Fertiliser plan

5.16.1 Cereal Crop yields

The following information will be inputted in this section :

- Crop
- Year
- Total weight in tonnes for harvested crop
- Moisture content of seed (%)

- Area of the field in Hectares

5.16.2 Lime

Lime required is generated from soil sample results previously entered. If there is a huge amount of lime to be spread per hectare this will be applied in 2 applications **FIG [AG] [46]**. No more than 7.5 Tonne per hectare should be applied in year 1. A minimum of 50% should be spread in year 1 while the remaining is spread in year 3[64].

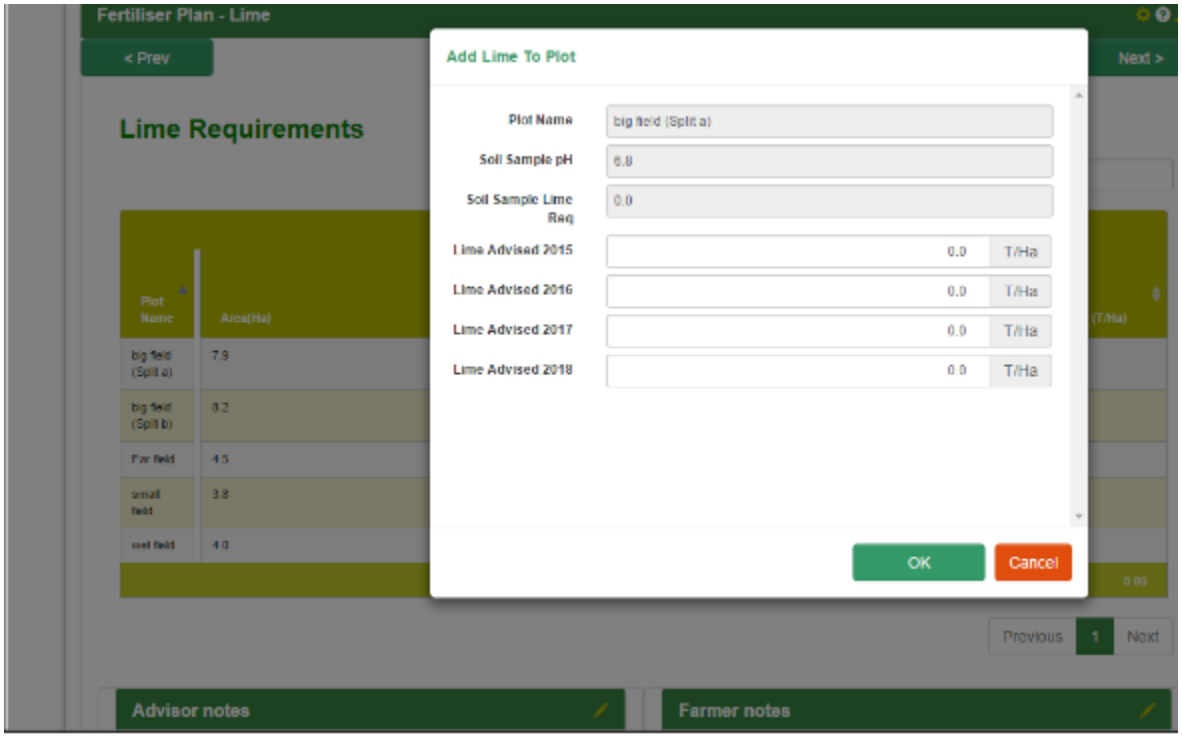


FIG [AG] [46]

5.16.3 Fertiliser Plan- Land and Fert Max

This is a summary of cropping area, Nitrates, how much land is in each Phosphorus Index and the maximum amount of fertiliser which can be used. This is a summary page so no data can be edited on this page.

5.16.4 Organic fertiliser

Each plot which has been previously entered will appear here in a list format. Each plot will also have the crop which it is growing. There will also be nutrient advice in a box adjacent to this information **FIG [AH] [46]**. Once organic fertiliser has been applied a nutrient balance will show between the advice and what's applied.
This section will give a farmer a plan where (s)he will apply his organic fertiliser (slurry/ farmyard manure). Ideally all organic manure should be spread on silage ground/ index 1 & 2 (Potassium index) [65]. This will give the farmer an extra chemical allowance for purchasing chemical Phosphorus.

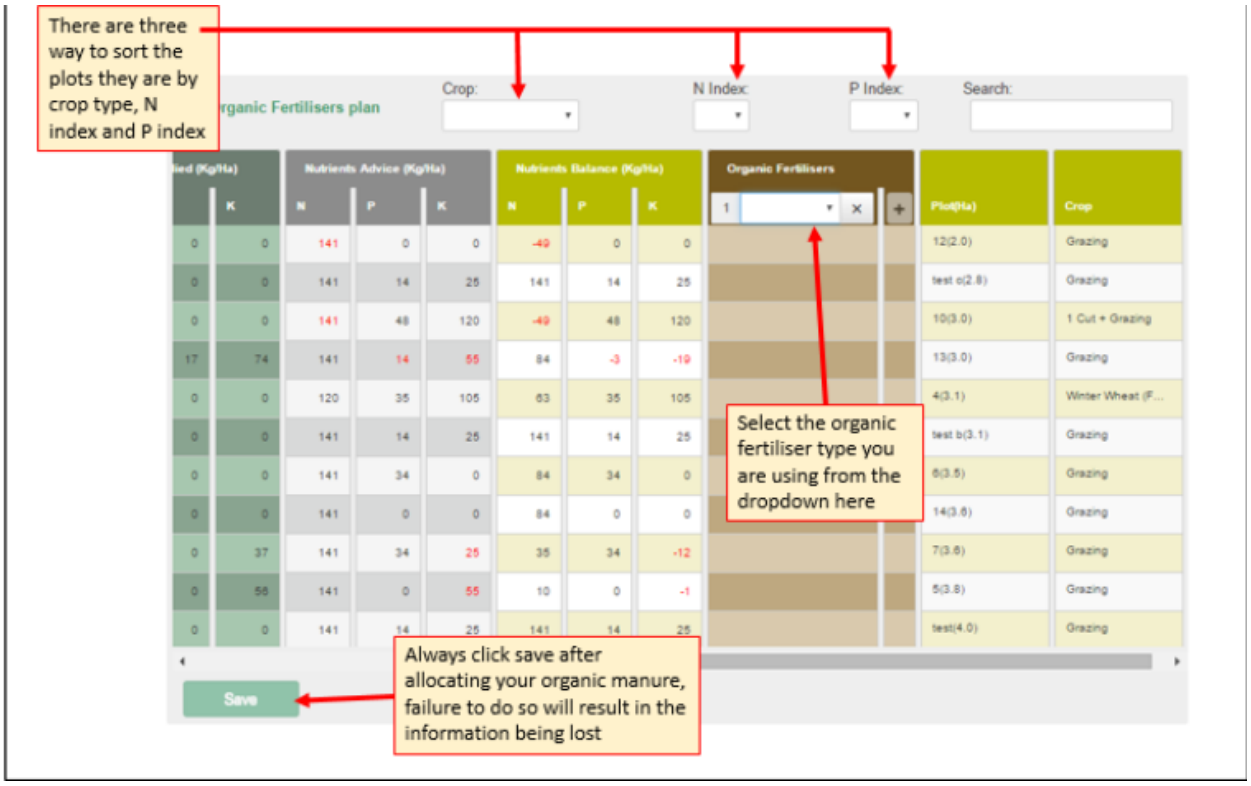


FIG [AH] [46]

5.16.5 Chemical fertiliser

Each plot which has been previously entered will appear here in a list format. Each plot will also have the crop which it is growing. There will also be nutrient advice in a box adjacent to this information **FIG [AI] [46]**.

There are numerous amounts of types of fertiliser which a farmer can spread. The choice of fertilizer which is spread will depend on the following:

- Farmer preference
- Price of fertiliser
- Crops growing
- Soil samples
- Land type
- Season
- Legal limits
- Merchant

When creating a fertiliser plan it is critical that an advisor picks at maximum 4 different types which suit the farmer. The advisor must create a plan which keeps a farmer within his limits ensuring he knows if the farmer has a previous opening stock. When applying fertiliser the advisor must also ensure he is basing the fertiliser off the soil samples. Soil samples will indicate if the soil is needing any particular type of fertiliser.

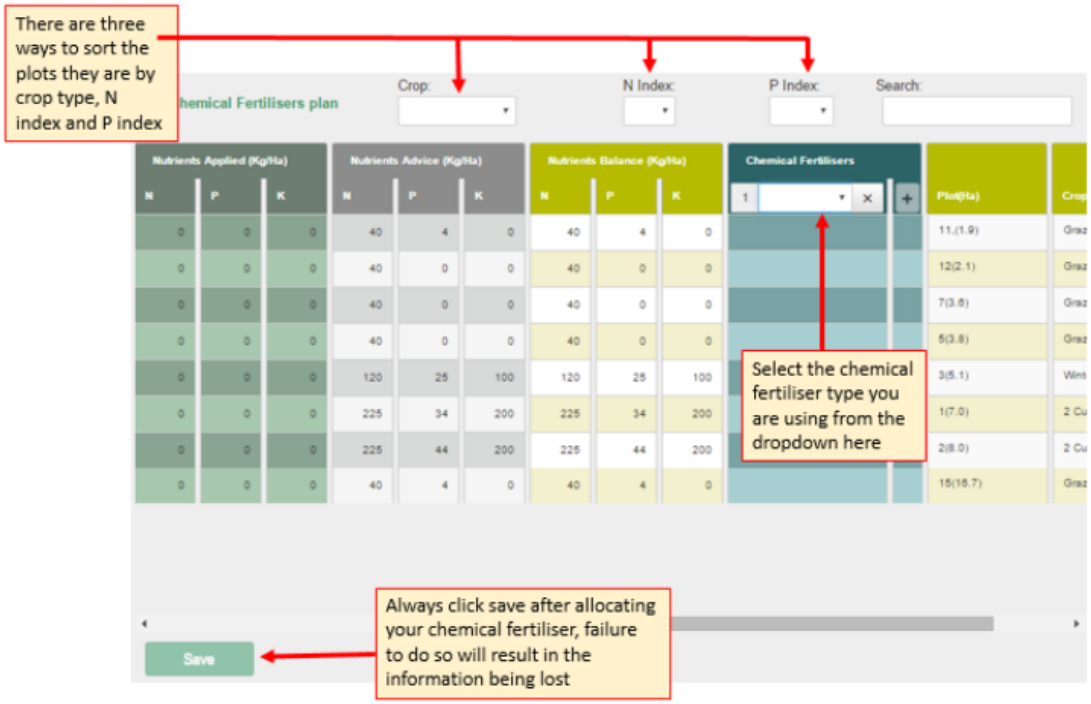


FIG [AI] [46]

5.16.6 Fertiliser Plan Summary

This is a list of fertiliser(s) which a farmer can purchase while staying within his legal limits. This is a summary page and no data can be edited.

5.17 Map Viewer

This section will print the field maps with various amounts of information.

5.17.1 Adding information to the map

There is a huge amount of information which can be added to the fields **FIG [AJ] [46]**, which will be color coded for the farmer when printed. If there is more than one piece of information it's advisable to print multiple sheets with a single piece of information on each map. Maps can be printed on either A4/ A3- landscape/portrait.
The advisor may choose to print maps of the entire farm or fields of choice depending on the situation.

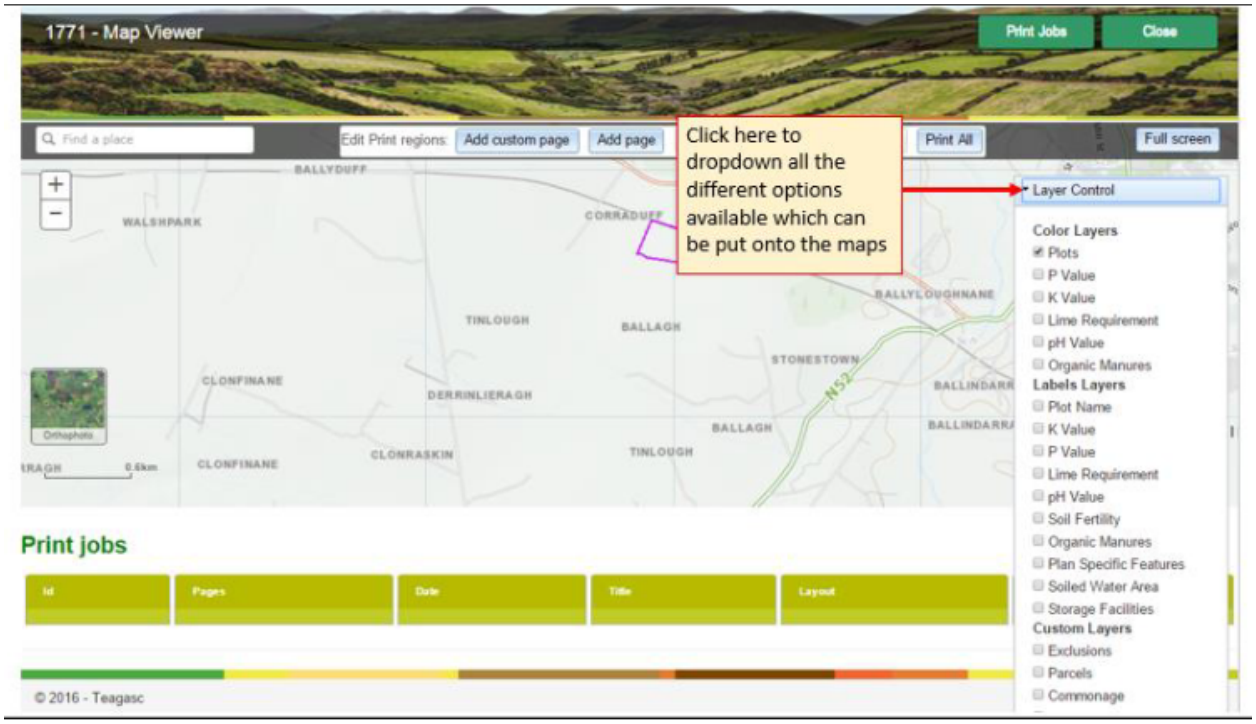


FIG [AJ] [46]

6.0 Explanation of Calculations: Nitrates

6.1 Nitrates figures:

Table 1: Nitrates information

Animal type	Kg Nitrates produced per animal per year
Dairy Cow	89 (change made in 2021) 85 previously [66]
Suckler Cow	65
Cattle 2 years plus	65
Cattle (1-2 Years)	57
Cattle (0-1 Year)	24[67]
Lowland ewe and lamb	13
Mountain Ewe and lamb	7
Lowland Hogget	6

Mountain Hogget	4

6.2 Grassland Stocking Rate

Animal type x Kg Nitrates produced per animal per year= Total Nitrates

Total Nitrates / Total Grassland Area (Hectares) = Grassland Stocking rate

Example:

10 Dairy Cows, 15 cattle 2 (2+ years) 4 cattle (0-1 year) on 20 hectares of grassland

(10 x 89) + (15x65) + (4x 57)

890 + 975 + 228= 2093 kg Nitrates

2093/20= 104.65 Kg Nitrogen per hectare= grassland stocking rate

6.3 Whole farm stocking rate

Animal type x Kg Nitrates produced per animal per year= Total Nitrates

Total Nitrates / Total farm area(Hectares) = Grassland Stocking rate

Example:

10 Dairy Cows, 15 cattle 2 (2+ years) 4 cattle (0-1 year) on 20 hectares of grassland + 3 hectares of Tillage

(10 x 89) + (15x65) + (4X 57)

890 + 975 + 228= 2093 kg Nitrates

2093/23= 91 Kg Nitrogen per hectare= Whole Farm stocking rate stocking rate

Note : this does not include import/ export

6.4 Livestock unit per hectare

- Dairy/ suckler cow/ cattle over 2 years old = 1
- Cattle 0-1 year: 0.4
- Cattle 1-2 years: 0.6 [24]
- Male or female sheep: 0.1 livestock unit each [25]

Animal type x livestock unit= total livestock units on the farm

Total livestock units on the farm / total hectares= Livestock unit per hectare

Example

10 Dairy Cows, 15 cattle 2 (2+ years) 4 cattle (0-1 year) on 20 hectares of grassland + 3 hectares of Tillage

(10 x1) + (15x1) + (4x0.4)

10+ 15 + 1.6= 26.6 livestock units

20+3= 23 Hectares Total area

26.6/23= 1.16 livestock units per hectare

6.5 Record 5 Land

Total area of field/ percentage of year leased. The total hectares from this calculation will then be added to the grassland area which will reduce the grassland stocking rate.

Example:

10 hectare field leased for 6 months.

6/12= 0.5 (land is rented for half of year)

10x 0.5= 5 hectares record 5 land

Previous grassland stocking rate figures:

- 2093 Kg Nitrates
- 20 hectares of grassland
- 104.65 Kg Nitrogen Per Hectare(Grassland Stocking rate)

New grassland stocking rate figures

- 2093 Kg Nitrates
- 20+ 5 = 25 Hectares of grassland
- 83.72 Kg Nitrates per Hectare (updated grassland stocking rate)

6.6 Imports

6.6.1 Slurry: Nitrates

For Every 1 tonne of slurry which is imported onto the farm the total nitrates will increase by 5 kg per tonne.

Example

Total nitrates on farm: 2093

Import : 10 tonne slurry

10 x 5= 50 Kg nitrates imported

Updated total nitrates: 2093 + 50= 2143 Kg Nitrates

Updated whole farm stocking rate: 2143/23= 93.17Kg Nitrates per Hectare

6.6.2 Farm Yard Manure: Nitrates

For Every 1 tonne of farm yard manure which is imported onto the farm the total nitrates will increase by 4.5 kg per tonne.

Example

Total nitrates on farm: 2093

Import : 10 tonne Farm Yard Manure

10 x4.5= 45Kg nitrates imported

Updated total nitrates: 2093 + 45= 2138 Kg Nitrates

Updated whole farm stocking rate: 2138/23= 92.95 Kg Nitrates per Hectare

6.7 Exports

6.7.1 Slurry: Nitrates

For Every 1 tonne of slurry which is imported onto the farm the total nitrates will decrease by 5 kg per tonne.

Example

Total nitrates on farm: 2093

export: 10 tonne slurry

10 x 5= 50 Kg nitrates exported

Updated total nitrates: 2093 - 50= 2043 Kg Nitrates

Updated whole farm stocking rate: 2043/23= 88.87Kg Nitrates per Hectare

6.7.2 Farm Yard Manure: Nitrates

For Every 1 tonne of farm yard manure which is imported onto the farm the total nitrates will decrease by 4.5 kg per tonne.

Example

Total nitrates on farm: 2093

export: 10 tonne Farm Yard Manure

10 x4.5= 45Kg nitrates imported

Updated total nitrates: 2093 + 45= 1998Kg Nitrates

Updated whole farm stocking rate: 1998/23= 86.86Kg Nitrates per Hectare

---

7.0 Explanation of Calculations: Phosphates

Total phosphates have only a function in one area of the application: fertiliser plan. The total phosphates comes from many areas throughout the app. The total organic Phosphates will have an influence on what chemical fertiliser is bought by the farmer

7.1 Phosphate figures:

Table 2: Phosphate Information

Animal type	Kg Phosphates produced per animal per year
Dairy Cow	13.0
Suckler Cow	10.0
Cattle 2 years plus	10.0
Cattle (1-2 Years)	8.0
Cattle (0-1 Year)	3.0

Lowland ewe and lamb	2.0
Mountain Ewe and Lamb	1.0
Hogget	1.0

9.0 Key spreading dates per zone:

Ireland is broken into 3 different zones which states when organic and fertilizer can and can not be spread on land. Farmers in these zones must also take into consideration weekly rainfall which will have an effect on how much storage (slurry/ farm yard manure) is required on the farm. [22]

9.1 Zone A:

- Carlow
- Cork
- Dublin
- Kildare
- Kilkenny
- Laois
- Offaly
- Tipperary
- Waterford
- Wexford
- Wicklow

9.2 Zone B:

- Clare
- Galway
- Kerry
- Limerick

- Longord
- Louth
- Mayo
- Meath
- Roscommon
- Sligo
- Westmeath

9.3 Zone C:

- Cavan
- Donegal
- Leitrim
- Monaghan [23]

9.4 Prohibited application period:

Table 3 : Commencement and end date for various fertilizers per zone [23]

Fertilizer Type	Start Date	End Date Zone A	End Date Zone B	End Date Zone C
Chemical	15th September	12th January	15th January	31st January
Organic	15th October	12th January	15th January	31st January
Farm Yard Manure	1st November	12th January	15th January	31st January

Taking the prohibited period into consideration the weekly rainfall must be accounted for when constructing a tank which is large enough to sufficiently hold slurry/ farm yard manure for the prohibited period which can be shown in **FIG [H] [26]**

10.0 What's used in other countries?

Having contacts in Australia I reached out to them to discuss the fertilizer limits which may be in place over there. This was of interest to me due to the extreme differences in climate. One of the main differences which was pointed out to me was farm size difference. The average farm size in Ireland is 43 hectares [17] compared to 4,311 hectares [18].

It was pointed out to me that there is no limit on fertilizer application, but due to the scale of farming a huge amount of soil testing (an important test to determine the rate of nutrition the plant may need [19]) is conducted on an annual basis.After the farmer receives back his soil test results he will make an appointment with his agronomist (a scientist who has specialised in caring and researching crops[20]). AgWorld [21] is a commonly used company in Australia. They will assist the farmers with their soil sample results and complete a fertilizer plan.

11.0 Motivation

After conducting a thorough research into both systems and talking with advisors I noticed the benefits and flaws of each. I also realised that there are many low production farmers in Ireland with no web application to conduct calculations. Going forward I decided that developing an application which was easily used and contained the benefits of both. I plan on making the application user friendly which is pleasant to look at.

12.0 My Proposal

I propose to build a web application which is easy to use. My application will have the benefits of both Microsoft Excel and the current webpage NMP(Nutrient Management Planning). This will be aimed at low production farmers and their needs. This app will have the following functionality:

- Develop stocking rates
- Incorporate how rented land will affect a stocking rate
- Inform farmers if they can import/ export
    - If farmers have to export a clear figure will be generated
    - If the farmer is importing other manures such as pig slurry, the webpage will have been able to inform the farmer of how much he can import while staying within the legal limit.

- Develop organic Phosphorus and Nitrogen limits
- Store soil samples
    - Be able to link soil samples to field
    - Larger area of land can be sampled with one sample
    - If soil samples are not present the farm will be assumed to be at index 3.
- Slurry/ farmyard slurry storage
    - Animal excretion levels will included
        - Type/ age of animal
    - How many weeks of housing
    - Location
    - Rainfall
    - covered/ uncovered tanks
    - Recommended space
    - Legally required
    - Freeboard and its rate will automatically be included in the calculation
- Fertilizer plan
    - Will contain a lime recommendation
    - Will take into confederation concentrates fed
    - Will take Organic Nitrogen and Phosphorus into account
    - Grassland and tillage can be combined as 1 whole farm fertilizer plan
- Clear easy to read report
    - This may or may not be requested by the farmer
    - Will only include the necessary topics
    - 1 page preferable

13.0 How it works

This part of the document will give a step by step guide on how to use the application when logged in as an advisor:

1. Once an account is made, login in with relevant username and password

2. The advisor will then ‘Create an assessment’. He will need the following information off a farmer

    a. Name

    b. Full Address

    c. Herd Number

3. The date will be inputted when creating an assessment- this will allow for a year to year comparison for future assessments.

4. The advisor will then press submit. This will bring the advisor to the next part of the application.

5. The advisor will need the following information off the farmer

    a. Total land he owns

    b. Total land he rents

        i. How long he rents this for

    c. How much tillage (if any)

    d. How much land was reseeded (if any)

6. The advisor will then press submit and will then be brought to the next section of the assessment.

7. The advisor will need the total number of the following animals off the farmer:

    a. Dairy cow

    b. Suckler cow

    c. Cattle (0-1 year)

    d. Cattle (1-2 years)

    e. Cattle (2 +)

    f. Mountain ewe and lamb(s)

    g. Lowland ewe and lamb (s)

    h. Mountain hogget

i. Lowland Hogget

j. Goat

k. Horse (3 years +)

l. Horse (2-3)

If the animal is not on the farm then the total will remain at 0

8. The advisor will then submit and will then be brought to a results page. The following information will be viewed here:

a. Total Nitrates

b. Total Phosphates

c. Total land area

d. Grassland Stocking Rate

e. Whole Farm Stocking Rate

f. Livestock unit per hectacre

9. The advisor can now adjust the livestock unit per hectacre if the farmer decides he wants to buy/ sell animals.

10. The advisor will then submit. The livestock unit per hectacre will update to reflect the updated data.

11. The farmer can then select import/ export or storage.

12. For the purpose of this step by step guide I will go to the import/ export section

13. The advisor must select which farmer is he working on from the drop down list

14. The farmer must declare the following information to the advisor:

a. If he planning to do an import/ export

b. If the import/export is farmyard manure or slurry

c. How much (in tonnage) will be either exported

15. The advisor will then press submit. This will redirect the advisor back to the results page which will show the affected organic Nitrates and Whole farm stocking rate.

16. The advisor will then go to the storage option.

17. The advisor will need the following information from the farmer:

    a. Type of storage he has- slurry/ farmyard manure storage

    b. If the facilities are indoor/ outdoor

    c. Dimensions (length x breadth x height)

18. The advisor can add multiple tanks for the farmer

19. Once all tanks are submitted the advisor will then be brought to the final results page which will show if the farmer has legally enough storage or not.

20. This final results page will contain all the results generated prior also.

Note:

1. Steps 1-10 must be completed for every farmer.

2. This information can be the final report if the farmer has no other assessment (s)he would like done.

3. Imports/ exports and slurry can also be done in the reverse order of above

4. Reports can be printed at any time

14.0 Technologies

14.1 Python

Python's popularity, support, versatility and its easy syntax made it a viable option for this project as studies and research take focus and having an easier language to work with simplified development. This application is designed to be deployed as a webapp, something Python excels at. The simplicity and less restrictions of the language made the development process much easier, as research, studying, experimenting with lambdas and generators, Python is a deep language with a progressive learning curve and combined with Django this application was possible. The more research performed the less code needed to produce working pages, debugging was easier as Python tolerated mistakes, when there was a small issue in the code base things didn't break completely in fact tracking errors consumed less and less time. Python's frameworks such as Django allowed much easier development of a very complicated intricate project.

14.2 Javascript

Javascript is a text based language allowing making web pages more interactive easier. Django's template system allowed it easier to separately design the look of the web pages but with javascript it was possible to outline input boxes with invalid input in a red border. This updates as the page is interacted with. Javascript is widely used in almost everything on the web. A confusing language at first after grasping enough it was possible to prevent Django exceptions with minimal amounts of code. Though it's possible to fully develop web applications in Django, adding javascript increased the amount of options available for configuring the web pages, in a more simplistic manner.

14.3 Flask

- Integrated support for unit testing
- Built-in development server and fast debugger
- Restful request dispatching
- Unicode base
- Support for cookies
- Templating jinja2
- WSGI 1.0 compliant
- Plus flask gives you some premier control to develop your project.
- HTTP request handling function

- Flask has a modular design and lightweight so that it can easy to transit into web framework with some extension
- Highly flexible [6]

14.4 Django

The app will be written in Python using Django technology as it is a free and open source web framework designed to make application development much faster and more effective. [7]

- Django provides a fully loaded framework with plenty of extras to ensure smoother development and more out of the box capabilities (user authentication, content administration, ..)
- Django is exceedingly scalable and very security focused, helping developers to avoid many common security mistakes and using User-Authentication system allows for a more secure way to manage user accounts and passwords.
- The app is designed to be used by Teagasc advisors and as Teagasc is a state run body, security is a huge concern as the app is designed to be the tool used to decide in the approval process of grants.

15.0 Potential Database Technologies

15.1 SQLite

After deciding to use django technology for this project, SQLite is the “testing” database engine that is supplied. SQLite was designed for low to medium traffic websites but how the engine handles this traffic depends on how heavily the website uses its database. SQLite uses a weakly typed SQL which does not guarantee domain integrity, as a string may be entered into an integer field. SQLite will try to attempt to convert this data between formats if possible, for example, if 123 was entered into a string column SQLite would try to insert the string “123” but this type of conversion is not guaranteed. SQLite is known to be one of the most widely deployed database engine yet most popularly used as an embedded database [51].

15.2 MySQL

MySQL is an open-source, relational database system that integrates with SQL and is very popular with web based applications. SQl, or Structured Query Language is used to store, retrieve and manage data in the relational databases and has become the leading industry standard for querying and manipulating

data, also offering the functionality of allowing other languages to be embedded using SQL modules, libraries and pre-compilers.

15.3 Final Decision

MySQL was the first choice for this project due to the capabilities and functionality it offers. Originally the idea was to have one major table to store all the data relating to the application, but after some thought and research discovered that MySQL works better and faster across multiple smaller tables. So the app's database was restructured.

Instead of a large database table containing everything, the table will contain keys to smaller tables which will hold the required data. This method of storing and locating takes full advantage of SQL's functionality providing a faster service.

Python's simplicity and versatility proved to be the correct decision, working so well with web development, simplifying the process meant less time focusing on errors and more time developing. Djangos framework provided the MVC model enabling separation of logic from the visual side, when pages were displayed in an acceptable manner the focus was on functionality.

16.0 Summary and Conclusion:

Developing this application has been a fantastic learning experience.

When this application was being discussed I was warned of the complications behind the development of this programme but I didn't believe them. I later learned when I started developing and implementing features the complexity of advisory work.

In order to be able to develop and build this application I had to understand what I was being asked to do as I later discovered that most of the calculations were not a straight forward equation. I soon learnt that when a figure has been produced that this can be purposely manipulated or altered by another equation- even location (county/ being indoors or outdoors) will affect the calculations.

Before I started building this application I was given no guide to work off- just a set of features of functionality which the application needed to perform. Last January I had a meeting with Robert Sherriff and he told me that my application was going to be very similar to what was currently in the system. I was then given more features to implement which would make the application unique.

When I had the application completed I showed it to Robert who seemed delighted with the flow and ease of use of the application. He was happy with the report page as it was described as 'farmer friendly' and was therefore easy to read by farmers. The application also proved it was accurate in its calculations.

The web application has a future in the advisory industry with a few more unique features.

17.0 Plagiarism Declaration

I hereby declare that this research project titled “Teagasc Advisors Application” has been written by me under the supervision of Dr. Christophe Meudec.

The work has not been presented in any previous research for the award of bachelor’s degree to the best of my knowledge.

The work is entirely mine and I accept the sole responsibility for any errors that might be found in the work, while the references to published materials have been duly acknowledged.

I have provided a complete table of reference of all works and sources used in the preparation of this document.

I understand that failure to conform with the Institute’s regulations governing plagiarism constitutes a serious offence.

Signature: *Damien Doran*

Date: 29/04/2021

Damien Doran (Student)

C00221791 (Student Number)

18.0 Bibliography:

18.1 Useful Acronyms

- NMP- Nutrient management Planning
- N- Nitrogen
- P- phosphorus
- K- Potassium
- Ha- Hectare
- Kg/N/ha- kilograms of nitrogen per hectare

- FYM- Farm Yard Manure
- AEOS- agricultural Environmental Scheme
- LPIS- Land Parcel Identifier System

18.2 Useful Definitions

- Organic manure: is a well decomposed material used in organic agriculture it is free from chemicals,harmful organisms and weed seeds either it is from an animal or plant origin[42].
- Slurry: watery mixture of insoluble matter :
- Drystock: cattle which are raised for the sole purpose of meat [44]
- Cross Compliance : Cross-compliance is a mechanism that links direct payments to compliance by farmers with basic standards concerning the environment, food safety, animal and plant health and animal welfare, as well as the requirement of maintaining land in good agricultural and environmental condition [45].
- Derogation: Allows farmers to have a higher stocking rate [14] - the stocking rate will go from 170 kg Nitrogen per hectare to 250 kg Nitrogen per Hectare [15]
- Bovine: Members of cattle group [40]
- pH: How acidic or basic something is [41]
- Dirty water: this is washing from milking parlour, farm diaries and washings from general work areas. This is generally from a concrete surface [56]

20.0 Appendix

I am emailing this address in case you are waiting on a reply

Are some of the screen shots sent to me duplicates?
Soil sample page – area restricted to 5Ha - unsure of the 85
Land page

- Owned -- does it matter ---- probably easier for the farmer to think this way
- Rented ---- does it matter ---- probably easier for the farmer to think this way
- Tillage land

- Can the tillage be included in the owned or rented
  Should the owned and rented define grass area?

- Farm stocking rate page
  As an agent I cannot see deductions for Record 5 or record 3 land
  I think a farmer who logs in online can see these deductions
  Could the app include these deductions / additions
  Low stocked farmers may be importing / letting off land to solve sr issues on other farms
  Basis for importing /exporting is the organic figure but as we discussed the available N and P is also a major concern for what can be imported.
  Organic figure / sr may be the first clue as to whether importing is possible
  Could there be a link to the available N / P limits as a follow on check for importing.

regards

Martin Doyle

Mobile: 087 9090525
Tel: 053 9239210

[52] Appendix 1: Email from Martin Doyle; Dairy Advisor

Apologies had meant to come back to you sooner on this. The idea is good in principal as there are a large number of farmers not in derogation/exporting etc that wouldn't have a NMP. A few observations I would make:

1. I presume there will be some way to link up soil results to plots. Maybe include a field name box as a way of linking samples as farmers much prefer this method rather than LPIS numbers. Could use LPIS numbers also

2. Livestock page looks a little cluttered and could put people off. Could you just leave the 5 cattle groups along with lowland ewes and lambs with the option to click on an 'add' button for extras? First 4/5 options would cover the majority

3. Similarly with the feed page. Maybe just leave in compound ration option and barley with the option of an 'add' button again

4. Most importantly on the last page total kgs of N & P won't mean much to farmers. It would be great if you had a drop down menu of fertilisers at this point that they could click on say 5 tonnes of 18-6-12 and this would automatically deduct from their total. Think this happens on the Teagasc fert app? If you could convert kgs to units also or give both options it would prob make more sense to them

The simpler you can make it the better I would suggest. Hope that's some help.

James

James Doran
James Doran, Drystock Advisor
Teagasc, Old Dublin Road, Enniscorthy, Co. Wexford.

[53] Appendix 2: Email from James Doran;Beef Advisor

Just a couple of observations I made there below.

Is P or K value in mg/l or index 1-4? Need to know as could be either
Dates- format day month year easier read
Lime required-most farmers T/acre, some T/Ha but need to say which it refers to
pH-water or smPh?
Owned land-Ha or acre?

Type of feed-is supplier name any relevance eg Glanbia?
Kg P per T fed?
Date purchased? As can get confusing if 2 years mentioned.
On totals tab-phosphates spelt wrong

So just on the layouts really.
If you want me to look at anything else let me know.

Tom

[54] Appendix 3: Email from Tom Deane; Drystock Advisor

That looks good & straightforward….a couple of spelling errors …correct ones are "Phosphorus" and "Beet Pulp" Can't remember now but was there a space for Field name aswell as field number?? Might be handy for farmers when checking individual fields if they don't now the number the name might be helpful. I didn't go through all the nitrates figures but recheck those to make sure all figures are correct.
Not sure if this is of any use but if you want to call me please do.

Kind Regards,

Deirdre Doyle
Teagasc,Old Dublin Road, Enniscorthy, Co. Wexford
Email : deirdre.doyle@teagasc.ie
Phone : 053-9239216
Mobile: 087-9409469
teagasc
Agriculture and Food Development Authority

[55] Appendix 4: Email from Deidre Doyle; Beef advisor

In relation to the NMP advisors application I make the following remarks.

1. The concept is well thought of and provides a simple to use tool for quick calculations.
2. It would be worth adding units to the application if possible to distinguish what the figures are representing. At the moment there is just figures which is a bit confusing to the user.
3. Overall I think it has potential so long as it does not get mixed up with the NMP that is already in place.
4. A bit up tidying up around units etc. will go a long way towards making it a successful application.

Regards,

Mark Boland

Agricultural Catchments Programme Advisor Teagasc, Showgrounds, Gorey
0539481077
0871151773

[70] Appendix 5: Email From Mark Boland

21.0 References

[1]Enterprise-ireland.com. 2020. *Teagasc - Enterprise Ireland*. [online] Available at: https://www.enterprise-ireland.com/en/start-a-business-in-ireland/food-investment-from-outside-ireland/why-ireland/food-research-and-innovation/teagasc.html>[Accessed 6 November 2020].

[2] Sherriff, Bob, 2010, Simple NaNp calculator,Teagasc[accessed 6 November 2020]

[3]Teagasc.ie. 2020. *Teagasc NMP Online - Teagasc | Agriculture And Food Development Authority*. [online] Available at: https://www.teagasc.ie/about/our-organisation/connected/online-tools/teagasc-nmp-online/[Accessed 10 November 2020].

[4] Hyde, T., 2020. [online] Available at: https://www.youtube.com/watch?v=vGyGJaMDil4&t=29s (This will display the results printed from the Nitrates Management Plan) [Accessed 6 November 2020].

[5] Teagasc.ie. 2020. Submitting GLAS NMP's And Maps To DAFM. [online] Available at: https://www.teagasc.ie/media/website/environment/soil/NMP-Online-Update-9_Submitting-GLAS-NMPs-and-Maps.pdf [Accessed 6 November 2020].

[6]benefits, E., Science, T., Science, A. and Debris, A., 2020. *Explain What Flask Is And Its Benefits | I2tutorials*. [online] i2tutorials. Available at: https://www.i2tutorials.com/explain-what-flask-is-and-its-benefits/ [Accessed 9 November 2020].

[7] Djangoproject.com. 2020. *Django Overview | Django*. [online] Available at: https://www.djangoproject.com/start/overview/[[Accessed 9 November 2020].

[8]Redfearn, D. and Bidwell, T., 2020. *Stocking Rate: The Key To Successful Livestock Production - Oklahoma State University*. [online] Extension. Available at: https://extension.okstate.edu/fact-sheets/stocking-rate-the-key-to-successful-livestock-production.html [Accessed 6 November 2020].

[9]Agriculture.gov.ie. 2020. [online] Available at: https://www.agriculture.gov.ie/media/migration/ruralenvironment/environment/nitrates/InfoLeafletNitrates220915.pdf [Accessed 1 November 2020].

[10]Gottstein, M., 2008. Watch your stocking rates in face of Nitrates Directive. *farming independent*, [online] Available at: https://www.independent.ie/business/farming/watch-your-stocking-rates-in-face-of-nitrates-directive-26346356.html [Accessed 9 November 2020].

[11]advice, C. and descriptions, J., 2020. *Agricultural Consultant/Adviser*. [online] gradireland. Available at: https://gradireland.com/careers-advice/job-descriptions/agricultural-consultantadviser[Accessed 9 November 2020].

[12] Teagasc.ie. 2020. *Grassland - Teagasc | Agriculture And Food Development Authority*. [online] Available at: https://www.teagasc.ie/crops/soil--soil-fertility/grassland/ [Accessed 9 November 2020].

[13] Plunkett, M., 2020. *Fertilizeradvice Forgrass Establishment*. [online] Teagasc.ie. Available at: https://www.teagasc.ie/media/website/crops/soil-and-soil-fertility/Fertilizer-Advice-for-Grass-Reseeding.pdf [Accessed 9 November 2020].

[14]Gov.ie. 2020. *Nitrogen Derogation Scheme*. [online] Available at: https://www.gov.ie/en/service/31e52-nitrogen-derogation-scheme/ [Accessed 9 November 2020].

[15] Martin, R., 2020. *Nitrates Derogation: 5 Questions You Need To Consider*. [online] Agriland.ie. Available at: https://www.agriland.ie/farming-news/nitrates-derogation-5-questions-you-need-to-consider/ [Accessed 9 November 2020].

[16] Hyde, T. and Smiddy, B., 2020. *The Nitrogen Derogation*. [online] Teagasc.ie. Available at: https://www.teagasc.ie/media/website/publications/2017/Segment-015-of-Todays-Farm-Mar-Apr.pdf [Accessed 10 November 2020].

[17] European Commission. 2020. *Agriculture - Ireland - European Commission*. [online] Available at: https://ec.europa.eu/ireland/news/key-eu-policy-areas/agriculture_en [Accessed 10 November 2020].

[18] Abs.gov.au. 2020. *7121.0 - Agricultural Commodities, Australia, 2015-16*. [online] Available at: https://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/7121.0Main+Features12015-16 [Accessed 10 November 2020].

[19] Mallarino, A., 2005. *Testing Of Soils*. [online] encyclopedia of soils in the environment. Available at: https://www.sciencedirect.com/topics/earth-and-planetary-sciences/soil-testing[Accessed 10 November 2020].

[20] Indeed.com. 2020. *What You Need To Know About Becoming An Agronomist*. [online] Available at: https://www.indeed.com/career-advice/finding-a-job/agronomist[Accessed 10 November 2020].

[21] gworld Farm Management Software. 2020. *Farm Management Software; Manage Risks And Rewards. - Agworld*. [online] Available at: https://www.agworld.com/eu/ [Accessed 10 November 2020].

[22] Agriculture.gov.ie. 2008. *EXPLANATORY HANDBOOKFORGOOD AGRICULTURAL PRACTICE REGULATIONS*. [online] Available at:

https://www.agriculture.gov.ie/media/migration/farmingschemesandpayments/goodfarmingpracticesregulations/crosscompliance/publications/revisedhandbook2008.pdf [Accessed 10 November 2020].

[23] Phelan, S., 2020. *Slurry Spreading Season: When Can You Start?*. [online] Agriland.ie. Available at: https://www.agriland.ie/farming-news/slurry-spreading-season-when-can-you-start/ [Accessed 10 November 2020].

[24] En.wikipedia.org. 2020. *Livestock Grazing Comparison*. [online] Available at: https://en.wikipedia.org/wiki/Livestock_grazing_comparison [Accessed 11 November 2020].

[25] Agriculture.gov.ie. 2020. HELPSHEET / TERMS & CONDITIONSAREAS OF NATURAL CONSTRAINTS(ANC)ANDAREAS OF SPECIFIC CONSTRAINTS(ISLAND FARMING) SCHEMES2018. [online] Available at: https://www.agriculture.gov.ie/media/migration/farmingschemesandpayments/basicpaymentscheme/2018forms/ANCTandCs2018.pdf [Accessed 11 November 2020].

[26] Clarke, P., 2020. *Winter Facilities*. [online] Teagasc.ie. Available at: https://www.teagasc.ie/media/website/animals/dairy/WinterFacilities.pdf [Accessed 11 November 2020].

[27] Teagasc.ie. 2011. *Reseeding*. [online] Available at: https://www.teagasc.ie/media/website/animals/beef/Grazing-Guide-Book-2011_70-91.pdf [Accessed 11 November 2020].

[28] Mark, P., Lalor, S. and Mooney Finn, L., 2012. How to read and properly understand your soil tests. *Framing Independent*, [online] Available at: https://www.independent.ie/business/farming/how-to-read-and-properly-understand-your-soil-tests-26894854.html [Accessed 11 November 2020]

[29] Green, B., 2015. *Organic Fertilizer - An Overview | Sciencedirect Topics*. [online] Sciencedirect.com. Available at: https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/organic-fertilizer[Accessed 11 November 2020].

[30] Agriculture.gov.ie. 2020. *1Nitrates Regulations –How To Avoid Breaching The Limits*. [online] Available at: https://www.agriculture.gov.ie/media/migration/ruralenvironment/environment/nitrates/InfoLeafletNitrates220915.pdf [Accessed 11 November 2020].

[31] Fao.org. 2020. *3. DEFINITIONS*. [online] Available at: http://www.fao.org/3/y1453e06.htm[Accessed 11 November 2020].

[32] Kavanagh, S., 2020. *Concentrate Feeds*. [online] Teagasc.ie. Available at: ttps://www.teagasc.ie/media/website/animals/beef/concentrate-feeds.pdf> [Accessed 11 November 2020].

[33] Gouldings.ie. 2020. *Phosphorus (P) - Goulding Chemicals Ltd*. [online] Available at: https://www.gouldings.ie/advice/grassland/phosphorus/ [Accessed 11 November 2020].

[34] Mark, M., 2020. *Agri Environment Options Scheme | AEOS | Ireland*. [online] Agriculturalconsultant.net. Available at: https://www.agriculturalconsultant.net/schemes/aeos [Accessed 11 November 2020].

[35] Askaboutireland.ie. 2020. *Tillage Farming*. [online] Available at: http://www.askaboutireland.ie/reading-room/life-society/farming/farming-in-ireland-overvi/tillage-farming/ [Accessed 11 November 2020]

[36] Team, A., 2016. *What Is The Fertiliser Value Of Straw?*. [online] Agriland.ie. Available at: https://www.agriland.ie/farming-news/what-is-the-fertiliser-value-of-straw/ [Accessed 11 November 2020].

[37] independent. 2006. *Nitrates Directive Leaves Less Capacity For Slurry Storage*. [online] Available at: https://www.independent.ie/business/farming/nitrates-directive-leaves-less-capacity-for-slurry-storage-26372836.html [Accessed 11 November 2020].

[38] Agriculture.gov.ie. 2017. *UROPEAN UNION (GOOD AGRICULTURAL PRACTICE FORPROTECTION OF WATERS) REGULATIONS 2017*. [online] Available at: https://www.agriculture.gov.ie/media/migration/ruralenvironment/environment/nitrates/2017/SINo605271217.pdf [Accessed 11 November 2020].

[39] Cadogan, S., 2014. *Nitrates Regulations Must Be Followed*. [online] Irish Examiner. Available at: https://www.irishexaminer.com/farming/arid-20254680.html [Accessed 11 November 2020].

[40] Dictionary.cambridge.org. 2020. *BOVINE | Meaning In The Cambridge English Dictionary*. [online] Available at: https://dictionary.cambridge.org/dictionary/english/bovine [Accessed 11 November 2020].

[41] Augustyn, A., Zeidan, A., Zelazko, A. and Eldridge, A., 2020. *Ph | Definition, Uses, & Facts*. [online] Encyclopedia Britannica. Available at: https://www.britannica.com/science/pH [Accessed 12 November 2020].

[42[Subba Rao, A., 2020. *How Can We Properly Define Organic Manure?*. [online] research gate. Available at: https://www.researchgate.net/post/How-can-we-properly-define-organic-manure [Accessed 12 November 2020].

[43] Webster, M., 2020. *Definition Of SLURRY*. [online] Merriam-webster.com. Available at: https://www.merriam-webster.com/dictionary/slurry [Accessed 12 November 2020].

[44] ollinsdictionary.com. 2020. *Dry Stock Definition And Meaning | Collins English Dictionary*. [online] Available at: https://www.collinsdictionary.com/dictionary/english/dry-stock [Accessed 12 November 2020].

[45] Directorate, O., 2013. *OECD Glossary Of Statistical Terms - Cross-Compliance Definition*. [online] Stats.oecd.org. Available at: https://stats.oecd.org/glossary/detail.asp?ID=7350 [Accessed 12 November 2020].

[46] Teagasc.ie. 2016. *404 - Teagasc | Agriculture And Food Development Authority*. [online] Available at: www.teagasc.ie/media/website/environment/soil/NMP_User_Manual_2016__D5.pdf [Accessed 21 November 2020].

[47] Teagasc.ie. 2020. *Soil Sampling - Teagasc | Agriculture And Food Development Authority*. [online] Available at: https://www.teagasc.ie/crops/soil--soil-fertility/faq/soil-sampling-faq/ [Accessed 21 November 2020].

[48] **:** Gov.ie. 2020. *Land Parcel Identification System (LPIS)*. [online] Available at: https://www.gov.ie/en/service/1eb4d-land-parcel-identification-system-lpis/ [Accessed 21 November 2020].

[49] Teagasc.ie. 2020. *Organic Manures - Teagasc | Agriculture And Food Development Authority*. [online] Available at: https://www.teagasc.ie/crops/soil--soil-fertility/organic-manures/ [Accessed 22 November 2020].

[50] Available at: https://www.agriculture.gov.ie/media/migration/ruralenvironment/environment/nitrates/2019/derogationforms/Nitrates%20Derogation%202019%20Terms%20Conditions.pdf [Accessed 22 November 2020].

[51] Sqlite.org. 2020. *About Sqlite*. [online] Available at: https://www.sqlite.org/about.html [Accessed 10 December 2020].

[52] Martin Doyle- Profile at Teagasc- www.teagasc.ie/contact/staff-directory/d/martin-doyle/

[53] James Doran- Profile at Teagasc- www.teagasc.ie/contact/staff-directory/d/james-doran/

[54] Tom Deane- Profile at Teagasc www.teagasc.ie/contact/staff-directory/d/tom-deane/

[55]Deirdre Doyle- Profile at Teagasc www.teagasc.ie/contact/staff-directory/d/deirdre-doyle/

[56] dlib.everysite.co.uk. 2021. *ARCHIVE: Codes of Good Agricultural Practice - Definitions - Dirty water - definition*. [online] Available at: http://adlib.everysite.co.uk/adlib/defra/content.aspx?id=000IL3890W.16NTBWZXV86YN [Accessed 15 April 2021]

[57] TheFreeDictionary.com. 2021. *Concentrated Feeds*. [online] Available at: https://encyclopedia2.thefreedictionary.com/Concentrated+Feeds [Accessed 15 April 2021].

[58] Agriland.ie. 2015. *How to utilise the zero-grazing system - Teagasc - Agriland.ie*. [online] Available at: https://www.agriland.ie/farming-news/how-to-utilise-the-zero-grazing-system-teagasc [Accessed 15 April 2021].

[59] Teagasc.ie. 2012. *Studies on themanagement andutilisation of soiledwater and dilute slurryon Irish farms*. [online] Available at: https://www.teagasc.ie/media/website/publications/2012/5796.pdf [Accessed 15 April 2021].

[60] Coffey, R., 2021. *Dry Period- An Important Phase for a Dairy Cow | Animal & Food Sciences*. [online] Afs.ca.uky.edu. Available at: https://afs.ca.uky.edu/content/dairy-dry-period-an-important-phase-for-a-dairy-cow [Accessed 15 April 2021].

[61]Robert Sherriff Profile: https://www.teagasc.ie/contact/staff-directory/s/robert-sherriff/

[62] Teagasc.ie. 2021. *Basic Size*. [online] Available at: https://www.teagasc.ie/media/website/animals/dairy/Bale_size.pdf [Accessed 15 April 2021].

[63] Geoline Lining Systems: Stormwater Attenuation & HDPE Geomembrane Lining. 2021. *Slurry Lagoon - Farm Effluent Slurry Stores by Geoline Ltd*. [online] Available at: https://www.geoline.ie/agricultural-lining/slurry-lagoon/ [Accessed 15 April 2021].

[64] Teagasc.ie. 2021. *Lime - Teagasc | Agriculture and Food Development Authority*. [online] Available at: https://www.teagasc.ie/crops/soil--soil-fertility/faq/lime-faq/ [Accessed 15 April 2021].

[65] Agro, G. and Lawlor, S., 2021. *Best results from slurry within a fertiliser programme for grassland - Grassland Agro*. [online] Grassland Agro. Available at: https://grasslandagro.ie/best-results-from-slurry/>[Accessed 18 April 2021].

[66] Phelan, S., 2020. *Nitrogen excretion figure for dairy cow rises in Teagasc review - Agriland.ie*. [online] Agriland.ie. Available at: https://www.agriland.ie/farming-news/nitrogen-excretion-figure-for-dairy-cow-rises-in-teagasc-review/> [Accessed 18 April 2021].

[67] Hyde, T., 2017. *The Nitrogen Derogation*. [online] Teagasc.ie. Available at: https://www.teagasc.ie/media/website/publications/2017/Segment-015-of-Todays-Farm-Mar-Apr.pdf [Accessed 18 April 2021].

[68] Leahy, J., 2021. *CropsEnvironment& Land UseProgrammeAdvice on LimingAdd life to your land and profit to your business*. [online] Teagasc.ie. Available at: https://www.teagasc.ie/media/website/environment/soil/Advice-on-Liming-Leaflet.pdf [Accessed 19 April 2021].

[69] Mark Plunkett, L., 2019. *Grassland P & K Advice Mark Plunkett Johnstown Castle, Wexford - ppt download*. [online] Slideplayer.com. Available at: https://slideplayer.com/slide/14346181/ [slide 20] [Accessed 19 April 2021].

[70] Mark Boland profile: www.teagasc.ie/contact/staff-directory/b/mark-boland/

[71] Pat, C., 2021. *Winter Facillities*. [online] Teagasc.ie. Available at: https://www.teagasc.ie/media/website/animals/dairy/WinterFacilities.pdf [Accessed 29 April 2021].