KTIF SG Final Report Template

1. PROJECT TITLE/APPLICANT

1.1 **GRASSROOTS Driving Improvements in Grass Breeding and Productivity**

1.2 SRUC is the principal Research, Consultancy and Educational organisation in Scotland on all aspects of land management and agriculture.

2. EXECUTIVE SUMMARY

2.1 The aim of GrassRoots was to provide a list of improvements that could be addressed within the agricultural grass and clover breeding programmes being undertaken in the UK and elsewhere. By breeding and development of existing grasses as well as introducing novel species, productivity could be increased without necessarily increasing inputs.

These potential improvements were led by a group of grassland farmers in south west Scotland.

There was also some input from the farmers as how to improve the systems for testing grasses and clovers and make it more appropriate for farmers in Scotland.

The individual items of the 'wish list' were expanded upon by SRUC to provide some background to their importance and potential impact.

The main factors for development in grass/clover breeding were:-

- Development of existing agricultural grass and clover varieties
- Developments in growth in acidic soils
- Investigation of non UK grass and legume species for use in Scottish conditions
- Development of testing system to include livestock palatability

The findings were summarised and forwarded to representatives of major forage breeders and their responses included in a report document.

3. PROJECT DESCRIPTION

Two on-farm meetings with farmers in SouthWest Scotland (Wigton and Campbeltown) were carried out during December 2019 and January 2020. Members of SAC Consulting staff were also present.

South west Scotland was chosen as it is the main area for dairy farming in Scotland. As such intensively managed grassland is required and farmers are generally looking towards using highly productive grasses and clovers, along with high quality in terms of protein and sugar content. In addition there is a move towards maintaining or increasing farm output without increasing inputs.

These events also provided an opportunity to discuss the means by which new gras and clover varieties are field tested for UK National List, and Scottish Recommended List requirements

The discussions provided an output of ideas and concepts that could be used as aims for grass and clover breeders in the UK and abroad. These were summarised in a report and issued to representatives of the main breeders in order to obtain feedback.

It is planned that the outputs will provide a further basis for developments in grass/clover breeding in the future.

4. FINANCE

4.1 Initially £53,073
4.2 Detail of spend £11, 788.41
4.3 Noting any underspend and explain why

The project as described above was severely curtailed from that originally planned within which there would have been a number of field visits to grass variety trialling sites along with other on-farm meetings. These would have included a wider geographical catchment of farmers. The planned activities would also have included discussion with members of the Scottish seed trade, many of whom are associated with the grass/clover breeding programmes.

The advent of the viral pandemic in 2020 meant that it was not possible to undertake such meetiings

5. PROJECT AIMS/OBJECTIVES

4.1 The main aim of the project was to feed back to grass/clover breeders the views of grassland and livestock farmers in Scotland with regard to desirable attributes in agricultural grasses and clovers.

In addition grassland farmers were to be made more familiar with the practical aspects of field measurement of prospective new varieties within the National List and Recommended List systems.

6. PROJECT OUTCOMES

6.1 How aims/objectives were achieved

To a large extent the objectives have been accomplished within the restricted format of the project, involving a smaller number of farmers than originally planned.
The summary of the desired physiological attributes will be useful in further discussions with grass breeders.
Some of the desirable aspects may have been somewhat predictable. However other issues such as grass tolerance for acidic soils were of an innovative nature and are unlikely to being addressed by any breeders currently.

6.2 Milestones

As mentioned above the original planned project roll out was curtailed.

7. LESSONS LEARNED

7.1 Issues/Challenges

Within meetings and discussions with farmers it was evident that there was a lack of knowledge regarding the techniques used for testing new varieties of grasses and clovers. Although these were explained much more clarity could have been achieved if on-site meetings at the variety testing stations in Ayr and Edinburgh had been possible.

The overarching concept of the project was a two way communication between the grassland farming community in Scotland and the grass/clover breeding community. Part of this process was to be observation, on the ground, of how new varieties of grass/clover were field tested. In addition some discussion with Scottish Seed Trade was to be undertaken on the process of choosing appropriate varieties..

The aim had been to widen the farmer consultation process through further meetings including the variety field tests) and an on-line survey of farmers. However, all of these activities were severely curtailed as a result of the virus pandemic.

It was certainly unfortunate that it was not possible to visit field trial sites (SRUC, Ayr; SASA, Edinburgh) to see the grass variety trials in action. This would have allowed further discussion on the relevance of the testing methodology to commercial grassland farming.

However, the two dairy farmer groups with which discussions were held are involved with the most intensive grassland management in Scotland and it is likely that their comments would be relevant for most grassland farmers.

Their 'desire list' was subsequently expanded upon through a considerable literature search in order to assess the practicalities (or impracticalities) of their proposed developments for pasture production; particularly with regard to introducing non UK grass species.

The response from breeders also further indicated that some progress had already been made in developing desirable traits.

7.2 Impacts

The main impact has been the facility to allow farmers to express their requirements for agricultural grasses and clovers. In many cases this was the first opportunity to put these ideas across.

8. COMMUNICATION & ENGAGEMENT

8.1 Detail throughout the project's lifetime

The principal engagement was through the two farmers meetings in south-west Scotland. Engagement with seed suppliers/breeders was through the resulting report.

8.2 FAS Engagement (if applicable)

8.3 EIP-AGRI Engagement (if applicable)

9. KEY FINDINGS & RECOMMENDATIONS

The grassland farming community takes advantage of the grass/clover breeding and testing programme undertaken in the UK through improvements in grass yield year on year. However, there is little general understanding of how the testing programme is carried out in the field. Indeed there was considerable discussion on the methodology of new grass variety testing for the UK National List and Scottish Recommended List. In particular there was some concern by attendee farmers that the nitrogen fertiliser input to the grasses was considerably greater than that used in commercial farming . Although explanations were provided for the amount of nitrogen fertiliser used in testing, it was evident that some scepticism remained within the farmer groups

A means of allowing greater access to the testing system by farmers is needed.

Although the farmers consulted were interested primarily in breeding to increase yield, there was also some of interest in environmental impact; for instance increasing the ability of grasses to capture atmospheric carbon.
Environmental attributes of grasses need to be taken into consideration in breeding programmes.

10. CONCLUSION

The summary report from the grassland farmer consultation will form a basis for further interaction with the seed trade and grass/clover breeders for a number of years. Through its research activities SRUC is frequently in communication with the plant breeding community and the report will form a basis for future on discussions objectives for grass and clover breeding.

11. ANNEXES

Grass Breeding Requirements

Perceptions of Grassland Farmers in South West Scotland

Grass Breeding Requirements.

Perceptions of Grassland Farmers in South West Scotland

Derived from Farmer Meetings and Discussions at Wigtown (2 Dec 2019) and Campbeltown (20 Feb 2020)

Introduction

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Grassland farmers can often be heard discussing the pros and cons of the grasses, clovers and mixtures used for grazing and conservation. Such discussions are normally focussed on the longevity of grass production , but on occasion other factors such as herbage quality are considered.
In order to identify the particular concerns along with potential improvements in grass and clover characteristics two meeting were arranged with farmers in south west Scotland. This area was chosen as a large proportion is used for dairying and the intensive management of dairying requires high productivity and quality factors in the herbage.
The aim was to provide a list of improvements that could possibly be addressed within the grass and clover breeding programmes being undertaken in the UK and elsewhere.
The individual items of the 'wish list' were expanded upon to provide some background to their importance and potential impact.
These were then forwarded to representatives of major international grass and clover breeders such as DLF in order to expand on the practicalities their of development.
The following sections list the factors raised by the farmers groups, along with some background information and then, where obtained, the views expressed by the grass breeders.

Physiological factors

Increased Sugar (Energy) content

It is fair to say that the main component of grass or any other herbage used by the livestock farmer is the energy content. Most of this is supplied by carbohydrate. In grass this is composed of sucrose and to a large extent fructans, longer chain molecules based on fructose. These are readily available soluble forms. A considerable amount of breeding work, particularly at IBERS in Wales has been involved with increasing their concentrations in the grass leaf.
However, other carbohydrate components of the plant leaf provide energy when metabolised within the animal rumen. In particular this is true for cellulose which comprises 25 to 30 % of plant dry matter. One drawback however, is that the metabolism of cellulose by rumen bacteria leads to production of methane, a greenhouse gas which is released by eructation. Apart from GHG factor this methane loss is also a loss of energy from the feed. The current activities to reduce methane production from forage therefore may have a secondary positive effect of increasing its available energy to the animal.

It is also worth noting that there could be potential for raising the energy value of the herbage by increasing its fat, or lipid, concentration. At present this is normally around 5%. However, the energy value of fat is twice that of carbohydrate and so considerable advantage could be gained by even a small increase in its content. Some breeding activities in this area have been undertaken at IBERS in Wales.

Breeders comments

Total volume of methane production is not affected by fat or hemicellulose concentration in the diet, but when expressed as volume per unit of DMI, fat decreases methane production. Increasing hemicellulose concentration tends to reduce methane per unit of digestible NDF while improving NDF digestibility. Net energy balance for dairy cows is improved by increasing hemicellulose in diets containing lower amounts of fat suggesting that

manipulations of dietary ingredients can improve energy utilizations in lactating dairy cattle panel.
See "The influence of fat and hemicellulose on methane production and energy utilization in lactating Jersey cattle" O.R.Drehmel*T.M.Brown-Brandl†J.V.Judy*S.C.Fernando*P.S.Miller*K.E.Hales†P.J.Kononoff*

Increased Protein content

Grasses normally contain around 11 to 14 % protein content in terms of dry matter. For general livestock growth this is adequate. It should be emphasised that the protein within the grass is mostly used by the micro-organisms within the rumen for growth and division. The proteins produced by the rumen microbes are the main component of the protein absorbed by the animal. The actual proportion of protein in the grass which is ultimately converted to protein in the final products is actually very low ; around 10 % for meat and 20 % for milk. Indeed over 80 % of the protein ingested is excreted in equivalent terms. However, if protein levels are very low in the initial forage material the ability of microbes to convert cellulose to produce energy is greatly inhibited. For this reason protein intake needs to be sufficient for liveweight gain. Indeed for fattening animals, or in high productivity dairying, high protein concentrates derived from soya, beans or peas are commonly provided. This is a major expense, particularly as most of the protein equivalent is excreted.
However, the need to provide adequate protein from bought in products could be reduced if the protein content of grass or grass/clover forage could be increased.
As far as grass is concerned there are a number of factors to increasing protein content

- Inherent ability for conversion of soil derived ammonium to protein, which may be genetically controlled.
- Increased uptake of ammonium/nitrate from the soil. Again, this may be genetically controlled. However., it is also likely that uptake of available nitrogen will be indirectly enhanced by the formation of a denser, deeper root system.

In clovers the protein content will be determined primarily by the efficiency of atmospheric nitrogen fixation. There are inherent differences in protein contents of clover species ie red clover contains more protein than white clover. However, red clover generally is not tolerant of grazing and regular cutting, in contrast to white clover due to its stoloniferous growth habit. Current breeding programmes are developing a stoloniferous red clover.

However, it could also be useful to determine any genetic contrasts which allow red clover to acquire a greater protein content than white clover and/or whether the difference is a result of the differing rhizobium bacterial species in the two species.

Breeders comments
There is currently a programme for producing grazing-type red clover which will produce suitable varieties shortly.

Ability to grow in acidic soils

One of the major costs in grassland farming is the necessity to apply lime in order to counteract acidifying factors in soils. Most of the grasses and clovers, for maximal

growth, have a soil pH requirement of around 5.9 to 6.4. Once the pH falls below this level growth is reduced, primarily due to the reduction of nutrient availability in soil, particularly Nitrogen and Phosphate.
There are some less productive grasses such as Cocksfoot, which will tolerate more acidic conditions. However, the growth rate and quality of the grass is not as good as perennial ryegrass. A breeding programme to increase its productivity and quality would be of potential value. A number of other less productive grasses not commonly used for forage, which also grow well in acidic conditions, such as bent (Agrostis tenuis) grass. A programme to increase its productivity would be of interest.

Breeders Comments
In a grazing situation I still think that cocksfoot is underestimated and if managed properly can produce good results and it is more persistent than PRG. Cocksfoot has a high protein content etc., but it is paramount to harvest or graze cocksfoot in an early growth stage. Harvested too late in spring the digestibility penalty will be heavy.

White and red clovers have an optimum requirement for soils with a pH value of around 6.3 to 6.5. However, there are species of forage legumes that will tolerate lower pH values and are used on more extensive grassland production systems, namely Birdsfoot trefoil and Alsike Clover. There are varieties of Birdsfoot trefoil which have been developed and are currently grown in North America. However, a breeding programme to develop them further, particularly for Scottish/ UK conditions could be particularly rewarding. Not only would the establishment of such nitrogen fixing species be of value for grass forage quality ; they would also improve soil fertility over the long term, with the possibility of providing a fertile soil for rotational crop production.

Lower Fertiliser Nitrogen requirement
As mentioned previously, one of the factors for which breeding development would be desirable is the improvement in protein content, for a given soil N availability. However, with the price of nitrogen fertiliser being a major component in the cost of grassland production, there is a case for breeding productive varieties with a lower nitrogen requirement.
This would be a major achievement with regard to Perennial ryegrass which has already been under a productivity development breeding programme for over 70 years and it is doubtful that any step change in productivity for a set N input could be achieved.
However, there are other grass species in which little if any development has been made and the possibility exists for these to be scrutinised for their genetic potential.
This is of importance as there is an overarching move from climate change considerations towards the lowering of inorganic N inputs to all agricultural crops.

Breeders comments
Nitrogen Use Efficiency is being looked at in varieties of Perennial ryegrass and other species.

Ability to test for palatability when comparing varieties
Current national testing for variety suitability involves yield measurements, ground cover after cutting, disease tolerance and energy value. However, no indication is provided as to the palatability of a particular variety. This is obviously of major

importance. Lack of palatability is likely to be due to some physiological or chemical component of the grass leaf. For instance a high fibre content or the presence of an alkaloid which has an effect on taste.
Initial testing would be required to indicate the factors which reduce palatability; indeed some activity has already taken place. If the factors which reduce palatability can be identified and linked to a genetic source it may be possible to breed out without losing any overall productivity.

Breed for increasing root depth / density (improving carbon immobilisation)
In grassland production the extent of root density and length is generally ignored. It is only in years of severe drought that the depth of herbage rooting becomes an issue. However, there is now an increased interest due to the fact that decayed roots contribute towards the accumulation of organic matter in soil; thus locking up atmospheric carbon. The amounts that can be accumulated are significant, particularly under long term grassland .
Apart from developments in Festulolium species where ryegrasses are crossed with fescue and can produce deep rooting varieties, little attention has been paid to rooting within grass breeding programmes.

Breeders comments
DLF are part of the Radimax project in Denmark and this is providing a lot of information about varieties as well as different species. Root development is one of the focus areas for DLF breeding efforts.

Develop Other Grass Species currently used for Grassland
Timothy is a grass normally used within seed mixtures in order to provide some resilience to wet soil conditions. This is obviously a condition encountered in many parts of the UK. However, it does have drawbacks with regard to the length of time for establishment from seed and its relatively low metabolizable energy content. The latter factor is actually an advantage for its use as horse hay, where high energy grasses can cause health issues.
However, to improve its value for animal production an increase in its energy value would be of major interest. Indeed if this was achieved it is likely that Timothy would play a considerably larger part in grassland production. It already does so in Scandinavian countries as well as North America and for many cooler and wetter parts of the UK it could provide a much larger role in grassland production.
For drier areas of the UK Cocksfoot is often included in seed mixtures. It is a particularly fibrous grass and could benefit from developing a higher soluble sugar content.

Development of UK grass species not currently used in agriculture
Reed canary grass
Reed canary grass grows naturally in wet habitats of the UK. It is a tall growing perennial grass which spreads by rhizomes through the soil. It is however grown for animal fodder in North America and Scandinavia. It is most generally suitable for conservation rather than grazing. There is also considerable interest in its use for bio-energy; through incineration and anaerobic digestion. Trials in the east of Scotland showed that it can produce 14 tonnes Dry Matter per ha with a fertiliser input of only 60 kg/ha of N.

Bred cultivars are available from North America, but a major advantage could be achieved with regard to forage if both its metabolisable energy and protein content could be increased.

Yorkshire Fog
This grass is found in many localities and tolerates a wide range of soil types and pH. However, its nutritional value is low. A programme to increase the leaf quality of the species could be of value particularly for areas of low potential productivity

Common bent
A productive grass which is tolerant of acidic soils could have major benefits for grassland agriculture. Common bent is such a grass, but its overall productivity is currently low.

Red fescue
Red fescue species are very tolerant of a wide range of growing conditions both in terms of climate and soil conditions. Of particular interest is the fact that they tolerate soils of a relatively high salinity, which could make them more productive on coastal areas. Again productivity, and quality, could be improved.

Development of grass species used for grazing in other similar climatic regions

There are other parts of the world where climatic conditions are not too dissimilar to that of norther Europe and temperate-type grasses dominate particular areas. A considerable amount of investigation would be required to take advantage of these for UK conditions. Two potential sites are :-

North America

Some of the climatic areas in North America bear a similarity to that of north west Europe and species of grass and forages could potentially be of value foe Scottish/ UK conditions. Such grasses would include :- Meadow Foxtail and Meadow Brome

Russian Steppe

The Russian Steppe has a cold climatic condition but is relatively low in rainfall. However, there may be a number of species such as Festuca sulcata, Koelaria gracilis, Agropyron pectiniforma, Bromus inermis, Agropyron repens that, with breeding development, could have a role to play in UK grassland management.

Increased Productivity and Quality of Legumes for Herbage

Red clover

Red clover is a highly productive forage legume under UK conditions and yields are greater than for white clover. Moreover, its protein content is higher. However, there are some drawbacks which probably preclude its wider use.

Its physiology precludes its use for intensive grazing. A creeping habit for stoloniferous growth would be advantageous. This is currently under development

Secondly red clover often contains high levels of phyto-oestrogens which can have a deleterious effect on the fertility of ewes. If this could be reduced to safe levels for all varieties of red clover marketed in the UK it would lead to greater use.

Breeders comments

The grazing RC that DLF is looking at introducing has very reduced levels of phyto-oestrogens which would potentially alleviate concerns in its wider use even though it would still be prudent to be careful with ewes 6 weeks before and after tupping.

Lucerne

Lucerne can grow in cool climatic conditions . The main issue in Scotland that precludes its wider use is that its growth is severely restricted in wet soil conditions. This can be observed in patchy growth , where fields have localised wet areas.

The development of varieties that would tolerate wet soil conditions would markedly increase its use in the UK, particularly for high quality hay and silage.

Breeders comments

Presently this would be unrealistic as we need to look at species more adapted to Scottish conditions such as RC. Lucerne is a long way from this.

White clover

Although white clover is commonly grown with grass to enhance forage quality as well as to increase soil nitrogen levels, it does suffer from variability in vigour from year to year. There is no consistent cause of this variability in terms of weather or disease and it may have a genetic cause. An investigation into this variability and breeding to reduce the incidence and /or assess current varieties would be useful.

White clover is more temperature dependent than most agricultural grasses in terms of growth ie spring growth commences later than perennial ryegrass. For this reason the grass is often provided with an early spring dressing of N. The breeding of a more cold tolerant varieties could be of value.

Alternative legume species

A number of legume species grow naturally within the UK and have the potential for greater use in forage crops. Of particular interest is Birdsfoot trefoil for which, as mentioned previously, there are bred varieties within North America which have increased productivity.

Alsike clover has a similar habit to red clover in that it is of upright habit and duration of growth and productivity is three to four years. Like Birdsfoot trefoil its main advantage is that it is tolerant of wet and acidic soil conditions. Indeed it was traditionally used for seed mixtures designed for hill land. Again the potential exists to

improve its productivity and /or develop its use for lowland grassland but reducing the need for lime application.

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KTIF Final Report Guidance

Guidance:

- Introductory section explaining the basis for the project utilising rural development regulation you appropriate EU Grant Measure (ie. 16.1), making mention of the operational group (if appropriate), the roles and responsibilities of members and what the group set out to achieve;
- Report back on project aims and objectives and if they've been achieved – much of this can be pulled from the KTIF application;
- Detailed information on actual spend and how much was underspent (if any and a reason). How much funding was provided, from where (ie. 75% or 100% co-funded by SG/EU) and details of the project duration and milestones;
- Section on 'Lessons Learned'. Things which were highlighted as issues, resolved or to do better if done again. We understand some project won't work out as well as hope but be honest about this. By identifying limitations we can target the problem;
- Pull information in from the other reports your project has produced (ie. Progress Reports and Evaluation Reports) or as appropriate annex these;
- Remember your audience. Avoid too technical language and don't assume the reader has in-depth knowledge.
- A table detailing communications which have gone out (where, when and the size of the audience) and commentary would be beneficial;
- Detailed information on actual spend and how much was underspent (if any and a reason). How much funding was provided, from where (ie. 75% or 100% co-funded by SG/EU).

KTIF Secretariat

Agricultural Policy

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