Getting started in Arable Agriculture

Profitability of Rotations

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An ideal rotation should include a balance of different crops. The main aim of a rotation is to provide a profitable sequence that breaks the pest and disease cycle, improves weed control, prevents soil erosion and improves the nutrient cycle and soil condition.

The choice of crops used in a rotation affects many aspects of farming including, the time of sowing, the type and timing of the cultivation and the range of herbicides available for use. Some crops compete with weeds better than others, Table 1 shows the difference in commonly used crops in rotations.

The European Agricultural Fund for Rural Development
Europe investing in rural areas

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472986LH / 06.10.2021

Table 1 – Commonly used crops in rotations with their advantages and disadvantages

Crop		Competition with weeds	Benefits	Disadvantages
Autumn Crops – well suited to heavy soils, usually higher yielding. Provides overwinter ground cover.				
Cereals	Wheat	Medium	Achieve higher yields.	Can be expensive to grow (expensive seed, sprays, fertiliser).
	Barley	High	Early harvest allows early entry for subsequent OSR crop.	Gross margins often lower than other crops as grain sold for feed.
	Oats	High	Buyers' specifications can be difficult to meet.	Often doesn't out yield spring oats.
	Rye	High	Early harvest if for AD plant so workload is more spread.	Large Phosphorus (P) and Potassium (K) offtakes.
Broad-leaved crops	Beans	Low	No Nitrogen required, can fix Nitrogen for following crop.	Late harvest.
	Oilseed Rape	High	Herbicides available for Oilseed rape with no known resistance in weed populations.	Early drilling is required. Most broad-leaved weed control achieved by pre-emergence application. Volunteer OSR in following crop can be problematic.
Spring Crops – spreads workload, changes weed species and number, less suited to heavy soil.				
Cereals	Barley	High	Different markets for grain (malting or feed). Can provide a break from winter crops.	Malting barley specification can be difficult to achieve. Barley can be sold for feed but at a lower price.
	Wheat	Medium	Can provide a break from winter crops.	Late harvest.
	Oats	High	Can provide a break (not susceptible to takeall).	Difficult to control grass weeds.
Broad-leaved crops or other crops	Beans	Low	Nitrogen fix for following crop.	Late sowing can lead to a late harvest.
	Peas	Very Low	Nitrogen fix for following crop.	Delayed sowing reduces yield. Vining peas is very specialised.
	Ware or Seed Potatoes	High	Can use herbicides to control a wide range of weeds.	High capital investment. Can leave volunteers. Potatoes needs specialised equipment.

Land Suitability

According to the Macaulay Land Capability for Agriculture (LCA) **(https://map.environment.gov.scot/Soil_maps/?layer=1#)** land classification between 1 and 3.1 is considered prime agricultural land which is suitable for growing a wide range of crops. Land classified as 3.2, 4.1 and 4.2 is land that is suitable for growing a narrow range of crops, primarily grassland with short arable breaks. Understanding the land classification on your farm can assist in developing a sustainable rotation withing the capability of your soil and local climate.

Soil Health

A rotation should be designed to vary crop varieties, with more emphasis put on crops that help to protect soils and build soil organic matter, such as legume catch crops. Growing crops with different root lengths and structure helps to take advantage of soil varying nutrient profiles. More information about ways to improve soil health on your farm can be found at **(https://www.soilassociation.org/media/5560/scotland-seven-ways-to-save-our-soils.pdf)**.

Crop selection

Having a mixture of spring and winter crops allows the sowing and harvesting of the crops to be more spread out, not all the crops would be getting sown at the same time. However, harvest would be carried out over a longer period of time, and can be very weather dependent.

Choosing what varieties of crops to grow in a rotation can be a big challenge for a farm. Varieties should be chosen to suit your farm, taking in to account any history of disease, soil type and climate. Recommended varieties for Scotland can be found at **https://pure.sruc.ac.uk/ws/portalfiles/portal/34256787/SRUC_Cereals_Recommended_List_2021_Tables_Final_Ver1.pdf**

Winter barley is mainly selected in a rotation as it is early harvested which then allows early sowing of a subsequent crop of oilseed rape. If a replacement crop is used instead of winter barley, then it needs to be a crop that offers early entry for oilseed rape after mid-september (ideally sown between mid-August and mid-September) such as early maturing spring barley or rye grass.

Land should be divided in to blocks to regulate crops, for example you don't want half the farm in one crop one year then not having that crop at all the following year. However, this cannot always be avoided due to crop failures, a lack of market or demand for a specific crop and changing crop diversification policies (such as the change to the 3 crop rule). Planning what crop can be sown can be the biggest challenge of a rotation.

If including potatoes and vegetables in a rotation, a water source must be considered as they will need to be irrigated and a license would be needed to extract water. However, if the land is let out then that the responsibility will be with the grower.

Weed and disease pressure

One of the main driving factors for implementing a rotation on an arable farm is to reduce the disease and weed pressures. Protection against disease is achieved by interrupting the life cycles of many crop-specific diseases, so by the time the same crop returns to the field, the pest numbers have been severely depleted.

For example, takeall is a major threat to successive wheat crops, so breaking the cycle with a break crop reduce the impact on the crops. Swapping between spring and winter crops, the type of cultivation and crop type can help to reduce the seedbank for weeds.

Implementing a rotation reduces the reliance on herbicides, pesticides and insecticides, which is important as there is a shrinking number of chemicals authorised for use on crops and the risk of pollution when near to water courses. Some disease and pests are becoming resistant to chemicals, so a rotation makes a break the sequence.

Markets for Crops

Spring barley is the most commonly grown crop in Scotland, due to a high number of distillers making whisky for export using Scottish barley, making up 58% of the total arable area in 2019. The majority of spring barley is sold on malting contracts; however, it can be difficult to meet the specifications (set standards for moisture, nitrogen levels, screening and skinning's) of the maltings. Spring barley is also sold for animal feed at a lower price than malting barley, with a small amount sold or home saved for seed (royalties must be paid on all home saved wheat, barley and oat seed).

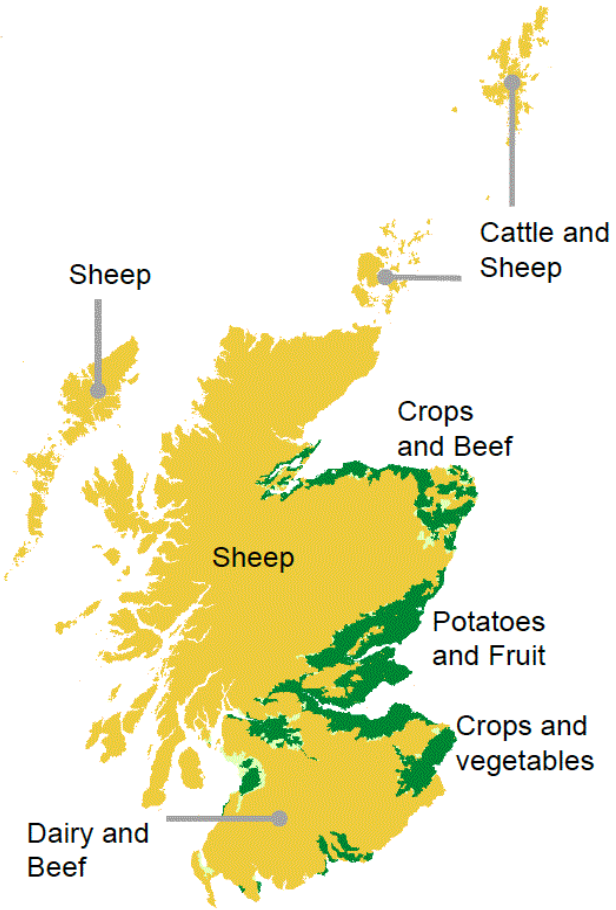

Figure 1: Agricultural Area of Scotland. Orange areas have limited growing conditions, usually hilly or rocky land suitable for livestock. Light green areas have better soil and can support crops usually grown for animal feed. Dark green areas can support vegetables, fruit and cereal farming for human consumption. (Scottish Government, 2019).

Winter barley is grown for animal feed, again with a small amount being saved or sold for seed. Winter wheat was grown on 28% of arable land in 2019, with it being sold mainly as animal feed, with some being sold for milling or distilling (there are different specifications for milling wheat to distilling wheat) depending on the variety chosen. Other crop that are commonly grown on arable land Scotland are oilseed rape, oats, potatoes, peas, rye or triticale.

In Central and North East of Scotland (Morayshire, Banff & Buchan especially) there is high demand for rented land for potatoes and vegetables (Figure 1). Rotations with seed potatoes involved need to make sure that the potato crops are at least 7 years apart, as per the regulations set by the SASA (Science & Advice for Scottish Agriculture, **(https://www.sasa.gov.uk/seed-ware-potatoes)**. Fields that might potentially grow potatoes will have to be PCN tested and negative, as PCN can drastically affect the growth of the potatoes.

Example break crops

Break crops provide an interruption for disease, pests and weeds. It also a balance of intensive crops, allowing the soil to replenish its nutrients. Example break crops are beans, peas, oilseed rape, carrots, potatoes and grass. Sclerotinia can be a problem amongst break crops, so splitting them up with arable crops can break the cycle.

Greening Requirements for an Arable Farm

In line with Scottish Government greening rules, if you farm over 15ha of arable land, then you must put 5% of your arable land into an Ecological Focus Area (EFA). Arable land is land used to grow arable crops, fallow, temporary grass, legume crops and herbaceous crops claimed for your basic payment scheme. There are seven options for EFA land that can be used on their own or in a combination: Fallow land, margins, catch crops, green cover, nitrogen-fixing crops, hedges, agro-forestry.

There are different rules on what is permitted depending on the type of EFA ground you choose, these can be found at **https://www.ruralpayments.org/topics/all-schemes/basic-payment-scheme/basic-payment-scheme-full-guidance/greening---bps/greening-guidance-2021/efa-ecological-focus-areas/**. When thinking about your rotation you must take in to account the EFA rules, as failing to implement them can lead to a reduced BPS payment.

Gross Margins for crops in rotations

Table 2 show the gross margins for commonly grown crops in rotations. The gross margins used below can be found in the farm management handbook **(https://www.fas.scot/downloads/farm-management-handbook-2020-21/)**. Output prices are the amount of income from grain sales and straw sales for the crop. Then the gross margin is the output minus the variable costs.

Yield of grain and straw is the main driver of the level of output. Some crops of straw are not sold instead it is chopped and incorporated back into the soil; this reduces the output of the crop, but the soil regains some of the nutrients that were lost to the crop. Straw is either sold baled (at a higher price) or in the bout, where the purchaser bales it themselves. Straw is sold to livestock farms who use it for feeding or bedding or for cover for carrots during the winter.

Grain prices are subject to supply and demand, not just in Scotland or the UK but globally. Some grain is grown on contracts, where a set price is locked in and some grain is grown and sold at spot price, which is the market price the day the grain is sold, this can be lower or higher than contract prices depending on markets.

Fertiliser cost can be the significant factor in the input costs. Fertiliser prices rise and fall due to supply and demand. A farm should look at reducing their reliance on bagged fertiliser and increase their organic fertiliser use, through soil analysis, the crop needs and nutrient management planning. Spray costs can also vary depending on which sprays are used and how many applications the crop needs.

The figures used in Table 2 are based on the higher end of yields so these values can depend on the yield achieved.

Table 2 – Gross Margins for common crops in an arable rotation

	Spring Barley	Winter Barley	Winter Wheat	OSR
Output (£/ha)	£1,229.00	£1,492.00	£1,812.00	£1,340.00
Seed (£/ha)	£80.00	£88.00	£98.00	£60.00
Fertiliser (£/ha)	£143.00	£188.00	£202.00	£173.00
Sprays (£/ha)	£56.00	£97.00	£148.00	£137.00
Other Expenses (£/ha)	£12.00	£16.00	£17.00	-
Gross Margin (£/ha)	**£938.00**	**£1,103.00**	**£1,347.00**	**£970.00**

Table 3 shows the gross margins for lant let out for crops commonly used in rotations. Output prices in Table 3 is the rent that could be received for the land. Rent prices can vary significantly between regions.

- **Pea land is normally around £444-458/ha (£180-185/ac) (Angus and Aberdeenshire area).**
- **Potato rent can range more, around £741-1482/ha (£300-600/ac) (Angus and Aberdeenshire area).**
- **Grass land rent can range depending on the area and age of grass form £99-370/ha (£40-150/ac) (ranging from £99-198/ha (£40-80/ac) in Stirlingshire to £124-370/ha (£50-150/ac) in Aberdeenshire).**

The figures used in Table 3 are for the Angus region. The 3rd party grower would be responsible for all costs associated with the potatoes carrot and pea enterprises.

Table 3: Gross Margins for land let out in rotation

	Grass	Potatoes	Carrots	Peas	Red clover
Output (Rent) (£/ha)	£346.00	£1,359.00	£1,730.00	£458.00	£346.00
Seed (£/ha)	£23.00	-	-	-	£151.00
Fertiliser (£/ha)	£96.00	-	-	-	£67.00
Sprays (£/ha)	£10.00	-	-	-	-
Other Expenses (£/ha)	-	-	-	-	-
Gross Margin (£/ha)	**£217.00**	**£1,359.00**	**£1,730.00**	**£458.00**	**£128.00**

Table 4 shows different example rotations, along with the gross margin for the rotation. The gross margin is an average over the whole rotation.

Table 4: Example rotations with gross margins

	Crop 1	Crop 2	Crop 3	Crop 4	Crop 5	Crop 6	Crop 7	Crop 8	Gross Margin (£/ha)
Example 1	Ware potatoes	Winter Wheat	2nd Wheat	Spring peas	Winter wheat	Spring barley	Ware Potatoes	Winter wheat	**£1187**
Example 2	Ware potatoes	Winter wheat	Spring barley	Spring peas	Winter wheat	Spring barley	Ware potatoes	Winter wheat	**£1137**
Example 3	Seed potatoes	Winter wheat	Winter barley	Oilseed Rape	Winter wheat	2nd Winter wheat	Spring barley	Ware potatoes	**£1221**
Example 4	Seed potatoes	Winter wheat	Winter barley	Oilseed rape	Winter wheat	Spring barley	Spring barley	Seed potatoes	**£1170**
Example 6	Grass	Grass	Grass	Grass	Grass	Potatoes	Winter Wheat	2nd wheat	**£642**
Example 7	Potatoes	Spring barley	Spring barley	Spring Peas	Spring barley	Carrots (2 years)	Red clover	Spring barley	**£928**

- **Calculating the average gross margin of a rotation allows comparisons to be made with other rotations. It also allows a farm to budget different crops to see what would be most profitable for the farm.**
- **There should always be a plan B drawn up in case harvest is delayed (stopping the next crop from being sown), the disease pressures increase, sprays become unavailable or if the market demand changes. Winter crops may need to be swapped out for a spring crop if the weather does not allow winter crops to be sown or they fail to grow.**

Grass in a rotation

- **If grass is included in the rotation (example 3) then it should be grass for 5 years to make it productive. Shorter leys can be more expensive as the seed costs are over a fewer number of years. The right mixture should be chosen for your selected length of time the land is in grass as some mixtures are specifically for 1-2years.**
- **Cereals can be undersown with grass (catch crop), which is an option for Ecological Focus Area (EFA) requirements. Under sowing grass will minimise any barren periods and reduces the time pressure of sowing grass after harvest, when leys would normally be established.**
- **Including grass in your rotation can help manage weeds problem in an arable rotation. Selecting the right variety is key to establishing the grass, with some varieties performing better for silage than grazing and other better for grazing. You must select the right variety for your use these can be found on the recommended lists (https://pure.sruc.ac.uk/ws/portalfiles/portal/34256787/SRUC_Cereals_Recommended_List_2021_Tables_Final_Ver1.pdf). Speak to you agronomist or advisor for assistance on selecting the correct variety for your farm. Grass could also cause a problem in a rotation as they can make grass weeds such as ryegrass difficult to manage in an arable rotation.**

Break Crops

- **Land let out for carrots may take up two years in the rotation. They are sown in mid-April to mid-May then are stored in the field through the winter under straw to stop frost damage, then are lifted in the following April or May. Thus, there being a higher rent for carrot ground. Some crops may be lifted early which would allow a spring crop to follow.**
- **Peas and beans including in a rotation can be either grown for vining or combined for animal feed and can count towards Ecological Focus Areas (EFA) requirements on an arable farm.**
- **Including OSR in a rotation allows different herbicides to be used, as different ones are licensed for oilseed rape to other cereals.**

Conclusion

To implement a successful rotation, a balance of different crops should be chosen, with the main focus being on breaking the disease and pest cycle. A successful rotation should reduce the reliance on sprays to reduce weeds, with a mixture of winter, spring and break crops breaking up the weed seed bank. There should always be a plan B drawn up, so the unexpected happens then there is a plan ready to implement. You should evaluate the local markets and contracts to see what crops are best suited for your farm. You should budget for different rotation scenarios in case of changes to weather or market demand.

More information:

More information about weed control in a rotation can be found on the AHDB website:
(https://projectblue.blob.core.windows.net/media/Default/Imported%20Publication%20Docs/AHDB%20Cereals%20&%20Oilseeds/Weeds/Managing%20weeds%20in%20arable%20rotations%20(2021).pdf)

More information on cereal disease can be found on the AHDB website:
https://ahdb.org.uk/knowledge-library/encyclopaedia-of-cereal-diseases

Defra have a website with more information regarding soil health:
(http://adlib.everysite.co.uk/adlib/defra/content.aspx?id=000HK277ZX.0AMSK34HZN81DH)

Gross margins for crops can be found in the Farm Management Handbook
(https://www.fas.scot/publication/fmh2021/)