**Linear Programming**

***January 2008 Exam***

**Question 1**

A farmer has 150 acres of land available to grow wheat and barley. It takes one day to sow an acre of wheat and two days to sow an acre of barley. There are 240 days per year available for sowing crops.

It takes 0.3 days to harvest an acre of wheat and 0.1 days to harvest an acre of barley. There are 30 days available each year for harvesting.

The profit from growing an acre of wheat is €149 and from growing an acre of barley is €235.

Using an appropriate linear programming method, find the number of acres of each crop the farmer should grow in order to maximise profits.

**(35 marks)**

Answer

**Variables**

Take Wheat as x and Barley as y

**Constraints**

*Sow Acre of:*

x+2y≤ 240

Plot coordinates

(0)+ 2y = 240

2y = 240

240 ÷2 =120

y= 120

Ordered pairs (x, y)

(0, 120)

x+ 2(0) = 240

x= 240

(240, 0)

*Harvest an acre:*

·3x + ·1y ≤ 30

Plot coordinates

·3(0) + ·1y ≤ 30

·1y = 30

30÷·1 = 300

y = 300

(0, 300)

·3(x) + ·1(0) ≤ 30

30 ÷·3

x = 100

(100, 0)

*150 acres of land*

*Note:*

*For this example, the constraint of 150 acres applies to both x and y ≤ 150*

x + y ≤ 150

(150, 0)

(0, 150)

**Variable function (Maximised outcome)**

*€149 per acre of Wheat, €235 per acre of Barley*

149x + 235y =

**Draw the constraint plots on a graph**



**Determine the feasibility area**

Using the origin (0, 0) i.e. (x, y) as the test point coordinates and substituting these values into the constraints expressions:

*Sow* (0) + 2(0) ≤ 240 True Shade towards the origin

*Harvest* ·3(0) + ·1(0) ≤ 30 True Shade towards the origin

*150 acres* (0) + (0) ≤ 150 True Shade towards the origin

The feasibility area is shown on the next graph confirmed by the test



All plots are tested true and each points towards the origin so high lighting the feasibility area. However, the optimal solutions are around the edge at each points of intersection



**Variable function (Maximised outcome)**

*€149 per acre of Wheat, €235 per acre of Barley*

149x + 235y =

Point A can be ignored as (0, 0) will not produce anything productive

Point B = (0, 120)

Point C ≈ (58, 92)

Point D ≈ (75, 75)

Point E = (100, 0)

Substituting these coordinate values into the variable Function; i.e. the money expression to find which will yield the maximise profit.

Point B = (0, 120) 149(0) + 235(120) = €28,200

Point C≈ (58, 92) 149(58) + 235(92) = €30,262

Point D ≈ (75, 75) 149(75) + 235(75) = €28,800

Point E ≈ (100, 0) 149(100) + 235(0) = €14,900

From the table values, point **C** yields the optimal return with **€30,262**

Just to check, if:

x = 58 and y = 92

58 + 92 = 150

The maximum acreage available