**Description**

This assignment will be done individually.

You are expected to show all working. To do so, I recommend submitting two documents; a Word document with your answers, and a supplementary Excel document showing your working for questions where appropriate. Please make sure the Excel spreadsheet is clear as to which question is being answered where, and all parts of your working is clearly labelled so that I can easily understand it. You will be able to submit more than one document on the Moodle submission page.

You are NOT expected to reference your work. However, please be very careful to ensure you do not plagiarise anyone else’s work.

Your aim is to conduct a benefit-cost analysis of two policy options to reduce greenhouse gas emissions in the agriculture sector of the fictional country of Nu Ziland. To do this, you will need to read the background about the country, understand the policy options, and answer the questions below to come to a conclusion.

**Background**

Nu Zild is a small, developed country, where the agriculture sector consists of just three dairy farms. As with all countries, the government must work out how the agriculture sector is going to play its part in the global fight against climate change.

The dairy farms in Nu Zild bear many similarities to New Zealand. They use pastoral systems, which are relatively efficient at producing milk with a low greenhouse gas emission intensity compared with other types of dairy farms. But, they still produce a lot of climate changing emissions and have potentially cost effective options available to them to mitigation their emissions.

The two main types of emissions dairy farms produce are a short lived gas, methane (CH4), and a long lived gas, nitrous oxide (N2O). Dairy farms produce some carbon dioxide too, but the government is currently considering how to address CH4 and N2O from agriculture as it already has policy addressing the other emissions.

The social cost of CH4 emissions is $2.50/kg and the social cost of N2O emissions is $200/t CO2-e (tonne carbon dioxide equivalent). These figures summarise the total cost to the world’s population from the emission of each of those gases, due to the increased climate heating they cause.

**Details**

The following shows the details of the farms and their climate change mitigation options.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Farms (baseline)** | | **Farm 1** | **Farm 2** | | | **Farm 3** |
| Annual production (kg of MS) | 100,000 | | | 120,000 | 140,000 | |
| Annual production costs ($) | 480,000 | | | 500,000 | 650,000 | |
| Annual total CH4 emissions (kg) | 2,400 | | | 2,800 | 3,500 | |
| Annual total N2O emissions (t CO2-e) | 12 | | | 14 | 23 | |

**Mitigation options available**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| In shed CH4 inhibitor feed additive | | **Farm 1** | **Farm 2** | | | **Farm 3** |
| Effectiveness (% reduction on baseline CH4 emissions per year) | N/A | | | 30 | 30 | |
| Annual costs (other than loss of production, in $) | N/A | | | 700 | 800 | |
| Annual loss of production (kg of MS) | N/A | | | 0 | 0 | |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Reduced application of N fertiliser | | **Farm 1** | **Farm 2** | | | **Farm 3** |
| Effectiveness (% reduction on baseline N2O emissions per year) | 8 | | | 8 | 11 | |
| Annual costs (other than loss of production, in $) | -2,000 | | | -4,000 | -79,990 | |
| Annual loss of production (kg of MS) | 300 | | | 510 | 10,000 | |

**Assumptions**

The Nu Zild government has specifically requested that you conduct your analysis over a time period of 20 years. Any costs or benefits after 20 years are considered irrelevant.

There are three farms in the country, and two potential mitigation actions that are viable (as above). The farms cannot change land use, and there are no other mitigation options available. All costs and benefits are assumed to be constant over the 20 year period.

For all costs and benefits (private and social) use a discount rate of 5% per annum. Assume all annual costs and benefits (including production revenue and costs, social benefits) occur at the end of each period. Therefore, the year 1 costs/benefits should be discounted for 1 year and so on.

Please assume a milk payment of $8/kg of milk solids (MS) supplied by the farmers.

You will also assume that any mitigation options will be implemented “today” (immediately) if they have a positive net present value to the farm. Remember, a negative cost is a benefit, but you should still include negative costs to farms in the “cost” analysis, as we want to keep all costs as costs to the farm, and all benefits as benefits to society.

Effectiveness of the mitigation options is calculated from baseline emissions, and you can assume there are no interactions between mitigations if you apply more than one.

**Policy Options**

Option A

Policy Option A is an immediate rule to reduce N fertiliser on all farms (all farms must implement the second mitigation action).

Option B

A tax of $0.20/kg of methane emissions, and $5/t of CO2-e of N2O is imposed immediately.

Option C

A tax of $0.20/kg of CH4 emissions, and $5/t of CO2-e of N2O is imposed immediately. Additionally, farmers will receive an $0.80 subsidy for every kg of CH4 that is reduced below baseline.

**Questions**

*Please show all of your working, with explanation. Report your answers to two decimal places.*

*Each question is worth 10 marks, for a total of 100.*

*For questions 8 to 10, limit your responses to no more than 500 words.*

1. What is the present value of the total cost of each mitigation option for each farm? (Remember to include any private benefits to the farm in this calculation as well as the cost of lost production.)

2. What are the annual emissions mitigated for each mitigation option for each farm? What is the annual cost of each kg of CH4 mitigated for the first mitigation option for each farm? What is the annual cost of each kg of N2O mitigated for the first mitigation option for each farm?

3. What is the present value of the social benefit of mitigating 1kg of CH4 each year for 20 years? What is the present value of the social benefit of mitigating 1t CO2-e of CH4 each year for 20 years?

4. What is the present value of the net benefit of Policy Option A? What is the benefit-cost ratio?

5. What is the present value of the net benefit of Policy Option B? What is the benefit-cost ratio?

6. What is the present value of the net benefit of Policy Option C? What is the benefit-cost ratio?

7. What is the net revenue to the government (taxes received – subsidies given) for each Policy Option?

8. Which policy option would you recommend the Nu Zild government implement and why? (You can recommend no policy if you decide that is the best option).

9. What are the limitations of your analysis? Comment on any assumptions made about the three farms, and any benefits you may not have included in the analysis.

10. What is the annual cost of the policy option you have recommended for each farm (including any taxes they have to pay and subsidies they receive)? What is this annual cost as a percentage of baseline profit for each farm? Is this distribution of costs equitable?