Thank you to both anonymous referees for their helpful comments. We have addressed each comment and revised the manuscript as follows:

Anonymous Referee #1

*Specific comments: I do have a few significant concerns. First, the authors need to specify the software version used and source for Biome-BGC and, as applicable, all other models/data used. Second, no error estimates are presented with any of the results, which is surprising. I understand that the emphasis is on differences between model runs, and not absolute results, but both do appear and it would be very useful to (e.g.) at least calculate differences across the driving GCMs.*

Author response: Software versions, sources and further information added for the following models: Biome-BGC model, LURNZ model, and PEST, as well as analyses performed in ArcGIS and statistical models performed in R. Also added sources of pasture growth data used for model calibration and validation.

Estimating model error is a complex undertaking and involves many different sources of uncertainty, including meteorological inputs, parameters, model structural uncertainty, and data collection. As the referee has recognized, the situation is particularly complex for integrated assessment activities, and our manuscript is structured to carefully define the differences between the analysed scenarios. Our goal is to provide a feasible solution for this complex activity to support small nations such as New Zealand. We note that in a policy setting, the model is meant to inform decision-making and an absolute uncertainty/error estimate may distract from the actual information required (Daigneault and Kerr, 2013). Yet, we agree with the referee's suggestion that we provide indications of uncertainty where simplicity can be maintained.

In response to this comment, we have carefully reviewed where more information on uncertainty can be referenced or included. We note that in many cases, uncertainty is described in supporting reports that are already referenced.

We further note that Figures 2, 3 and 4 partially address the referee's concern, but provide a visual rather than quantitative measure of uncertainty. Therefore, the most useful opportunity for us to quantify relationships is in model-data comparisons, and descriptive statistics have been added to Figures 3 and 4. These now provide quantitative as well as visual estimates of uncertainty with immediate relevance to our baseline estimates of production.

As the referee suggests, differences among GCMs can provide useful understanding. We are unsure, however, why the referee suggests reporting a quantitative comparison between only two GCMS. Detailed analysis of the differences among the ensemble of downscaled AR4 GCMs for New Zealand under the SRES A2 emission scenario (including comparison of annual mean temperature and precipitation response) is available in Renwick et al. (2013), which is now cited in the text where we introduce the climate change scenarios. We note that in the methods section, we qualitatively compare the different models used for the 2050 and 2100 projections as representing a mild 'mid-range' projection and a high-end response in temperature and/or precipitation. We include the result that in 2100 the GCMs predict an annual mean temperature increase of 3.0°C and 3.9°C from present day for New Zealand. We also visually compare the change in predicted rainfall between the GCMs in Figure 10. This clarifies our intent that the difference between the two scenarios can be interpreted meaningfully. We have further checked that the discussion of results reports the magnitude of the change relative to baseline for each projection, so that the difference between the two projections can be easily inferred by the reader.

Technical corrections:

1. *Page 3308, line 2: don't use define LURNZ (and DLUCS below) if not used again in abstract*
   Acronyms deleted from abstract and introduced later in the text.

2. *3308, 3: perhaps define "intensification"*
   Added clarification: "intensification of agricultural activity"

3. *3309, 10: NZD I assume? Clarify*
   Yes, numbers are in NZD. Added NZ$ in front of monetary figures

4. *3311, 3-26: not sure this is all necessary*
   Shortened paragraph to make description more concise

5. *3314: interesting!*
   Thanks!

6. *3318, 8-9: how? Biome-BGC doesn't include irrigation explicitly*
   Added details of how irrigation was simulated: "in this case irrigation was also simulated in the model during calibration by adding additional precipitation to the meteorological data input file when soil moisture deficit was above a threshold"

7. *3321, 25: reference should be to Table 2?*
   Yes, reference changed to Table 2

8. *3326, 14: might discuss briefly how consistent the White et al. results are with yours here*
   Added brief comparison to White et al. (2000) findings: "A general, comprehensive sensitivity analysis of Biome-BGC model parameters has been done by White et al. (2000). The authors found that variations in C:N ratio of leaves, fire mortality, and parameters relating to litter quality have the most impact on NPP in grass biomes, leading to the conclusion that productivity is primarily nitrogen-limited in nonwoody biomes. In comparison, our calibration reveals that the most significant effects on NPP in both sheep/beef and dairy systems come from varying two parameters, the maximum stomatal conductance and the fraction of leaf N in Rubisco. This suggests that in our model, New Zealand's highly-managed grasslands are primarily water- and photosynthesis-limited rather than nitrogen-limited."

9. *Table 3: define ME, and generally improve caption to provide more info*
   ME=Metabolisable energy, defined as the amount of energy available to grazing animals. Added this definition and more information to caption.

10. *Figures 3 and 4: ideally, statistically test measure:model regression line slope for intercept=0 and slope=1*
    Major axis regressions results have been added to Figures 3 and 4. As the referee points out, the model would be ideal if the intercept = 0 and slope = 1. In each case the calculated regression lines are statistically different from slope=1 and intercept=0; this is not unexpected given the complexity of the model.

References:

Daigneault, A. and Kerr, S.: What's the Use? How to Get More from Land-Use and Economic Models, Landcare Research Link Seminar, Wellington, New Zealand, October 2013.

Anonymous referee #2

*Comment: Could the authors comment on how realistic are changes in CO2 concentration that are not accompanied by changes in climate/weather patterns?*

Author response: We have inserted a sentence describing the intent of the 'Elevated CO2' scenario, and putting it in the context of the recent literature showing that up to 40 years may be required for the climate change associated with CO2 forcing to be observable above trends associated with regional and decadal variability. The following sentence has been added to section 2.5.3.: "This scenario was evaluated on the short timeframe of 2020 to provide a partial derivative of elevated CO2 effects on a timescale during which the effects of climate change might remain within the bounds of regional and decadal variability (e.g., Deser et al., 2012)."

*Comment: Can the authors also comment on whether changes in pasture production in relation to land use changes were or could be taken into account? I'm referring to a possible loss of production on land that has been converted from forestry to dairy, for example the large tracts of land in the central North Island.*

Author response: We are unaware of any studies directly comparing production between forestry and dairy post-conversion. However, conversion from forestry to dairy has been shown to affect albedo and radiative forcing (Kirschbaum et al., 2011), water yield (Beets and Oliver, 2007), soil carbon and nitrogen, and carbon storage (Bala et al., 2007) via direct and indirect pathways that will in turn affect productivity, none of which we have attempted to simulate in our land-use change scenarios. The detailed biogeochemical changes and feedbacks that occur during land-use change transitions are not currently included in the models we used and are beyond the scope of this study but could be added in future simulations if subsequent model development allows.

Text inserted in section 3.2: "In addition, we have not explicitly considered changes in carbon-cycle feedbacks and other biophysical effects due to land-use change and intensification. Other studies have demonstrated that land-use change affects characteristics such as albedo and radiative forcing (Kirschbaum et al., 2011), carbon storage (Bala et al., 2007), and water yield (Beets and Oliver, 2007). The simulation of these effects is beyond the scope of this study but could be considered in future work."

*Comment: Missing reference: Baisden, 2006*

Author response: Missing reference added: Baisden, W. T.: Agricultural and forest productivity for modelling policy scenarios: evaluating approaches for New Zealand greenhouse gas mitigation, Journal of the Royal Society of New Zealand, 36, 1–15, 2006.

References:

Bala, G., Caldeira, K., Wickett, M., Phillips, T. J., Lobell, D. B., Delire, C., and Mirin, A.: Combined climate and carbon-cycle effects of large-scale deforestation, P. Natl. Acad. Sci. USA, 104, 6550–6555, 2007.

Beets, P. N. and Oliver, G. R.: Water use by managed stands of Pinus radiata, indigenous podocarp/hardwood forest, and improved pasture in the Central North Island of New Zealand, New Zeal. J. For. Sci., 37, 306–323, 2007.

Deser, C., Phillips, A., Bourdette, V., and Teng, H.: Uncertainty in climate change projections: the role of internal variability, Clim. Dyn., 38, 527-546, doi:10.1007/s00382-010-0977-x, 2012.

Kirschbaum, M. U. F., Whitehead, D., Dean, S. M., Beets, P. N., Shepherd, J. D., and Ausseil, A.-G. E.: Implications of albedo changes following afforestation on the benefits of forests as carbon sinks, Biogeosciences, 8, 3687-3696, doi:10.5194/bg-8-3687-2011, 2011.