



Reducing land use through nutritional design: Can food forest feed the future?

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Background

Collectively food production has a great impact on the planet. Agriculture takes up 38% of available land and is responsible for 60% of global species losses due to land conversion (FAO, 2019). Western countries are responsible for a disproportionate share of land use with countries such as the Netherlands utilizing approximately 1.3 ha per person. In order to halt and potentially reverse the mass extinction crisis we are facing, the foods we eat and how we produce them must change.

Food forests are an agroforestry technique proposed as a solution to the environmental crisis of food production. While many environmental benefits such as improved carbon sequester, soil health and on-farm biodiversity outcomes have been reported, critiques remain about their poor land use efficiency compared to conventional systems in the West.

The question remains, can food forests be competitive with conventional systems in feeding people?

The objective of this Msc thesis was to examine if through improved nutritional design, land sharing production systems like food forests could reduce the land required to feed people.

Sub-objectives:

- Investigate nutritional gaps in the Droevendaal Food Forest
- Determine the maximum amount of people able to be sustained on 1 ha of the Droevendaal Food Forest
- Compare healthfulness of the diet produced to the average Dutch

Methods

Development of mixed integer linear programming model to maximize the people fed. The **objective function** selects a set of food items which were determined to be appropriate to grow in the case-study site. These are translated into **decision variable** which keep track of the inventory, consumption and production in each period as well as the associated land use area. These are then filtered through a set of **constraints** such as biodiversity requirements and level of imported nutrients which then produce a list of food items or calculated diets.

Results

Table 1. Deficient nutrients in Droevendaal Food Forest and foods used to fill nutrient gaps

Food item	Per 100g	DRV (%)*
Vitamin B-12		
Sea buckthorn	4.58 µg	115
Shiitake mushrooms	6 µg	150
Beet juice	4.15 µg	104
Sauerkraut	6.09 µg	152
Lupine tempeh	1.3 µg	33
Vitamin B2		
Shiitake mushrooms	0.3 mg	19
Vitamin D		
Mushrooms (UV exposed)	18.4 µg	123

Results

Moderate Constraint-Diet cropping arrangement (1ha)

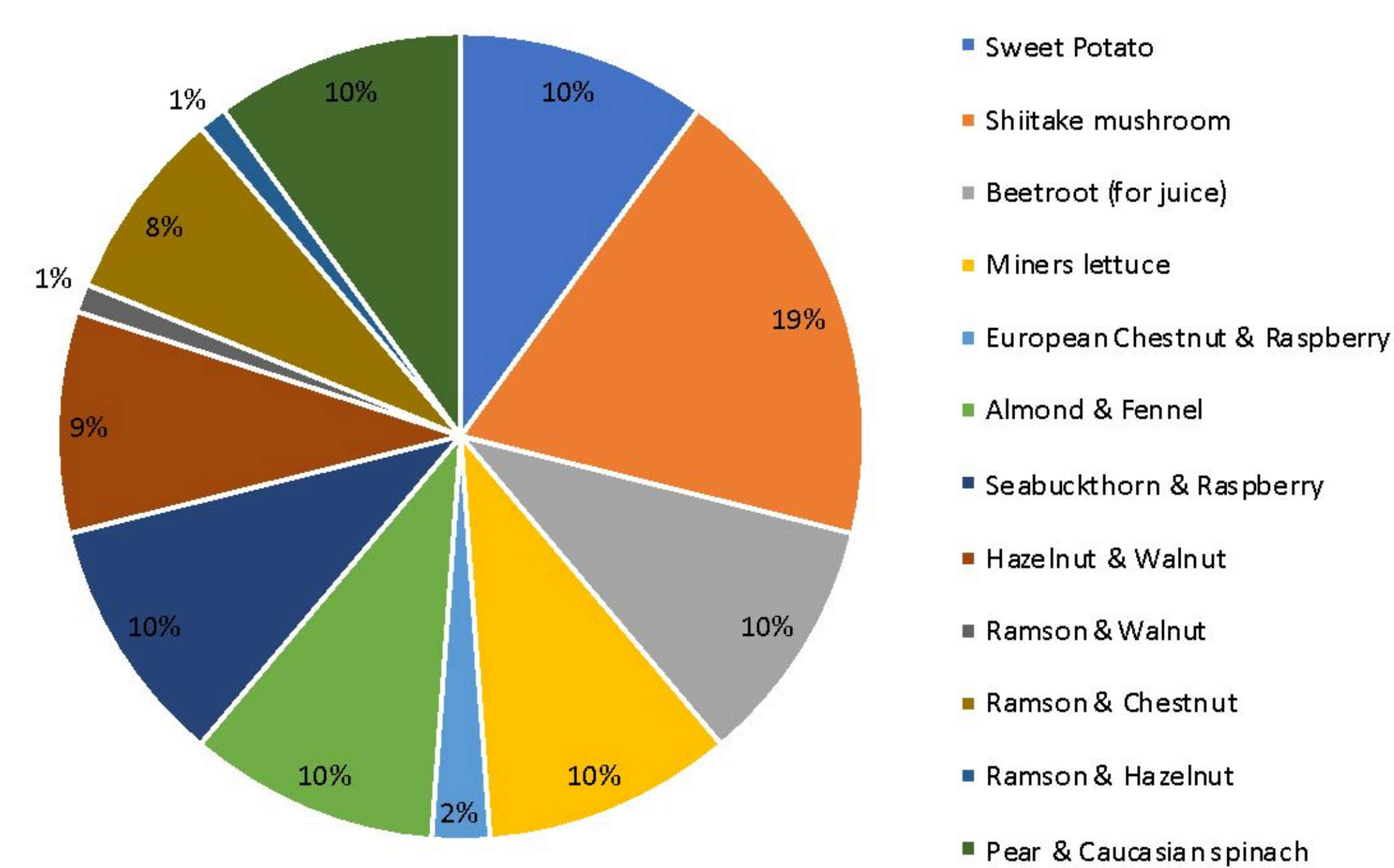
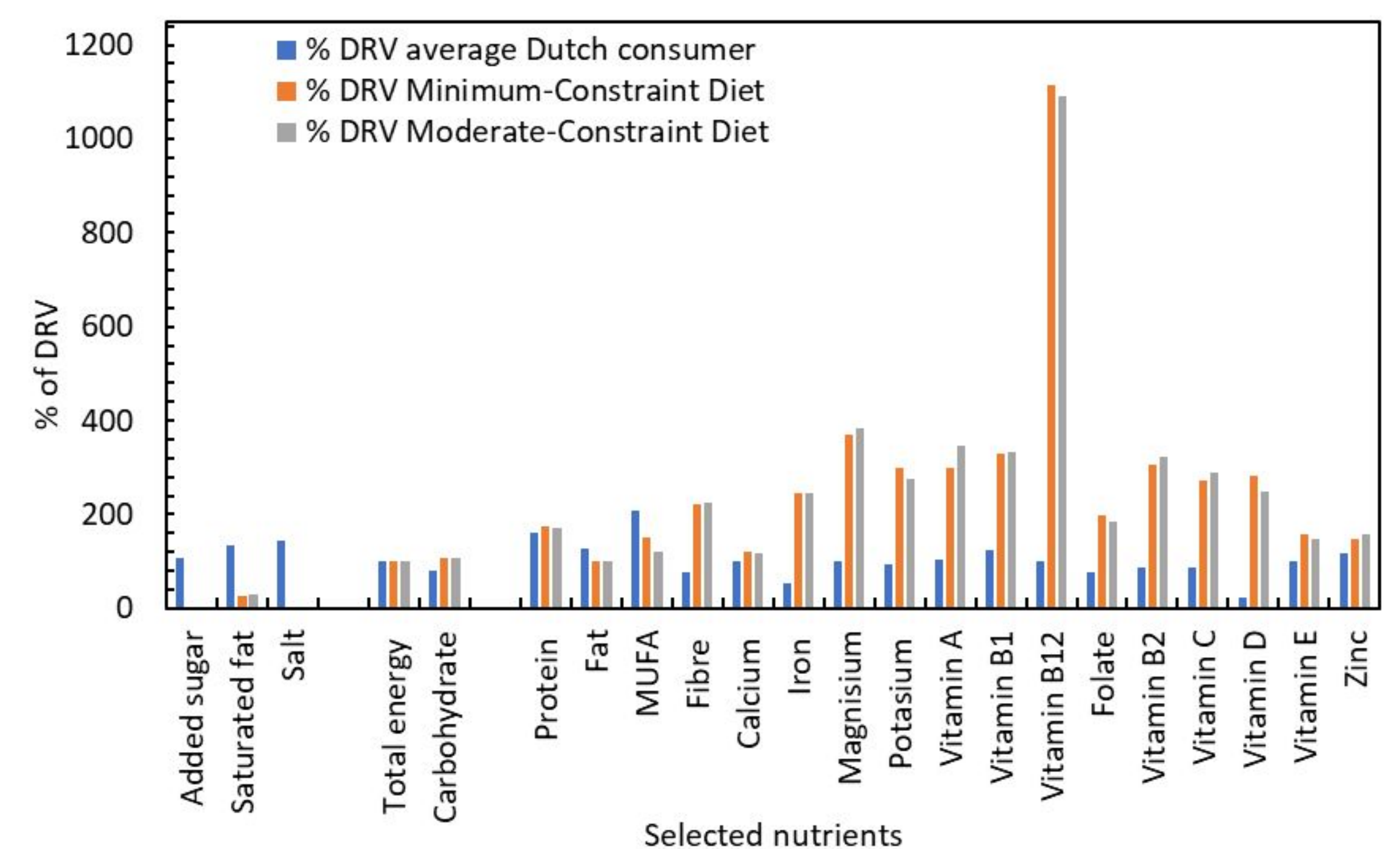


Figure 1. Cropping arrangement of scenario utilizing existing food forest foods and associated yields (apple, pear and walnut), with minimized nutrient imports and maximized crop biodiversity

Figure 2.

Comparison of developed diet scenarios of 2000kcal with the average Dutch daily intake of Nutrients standardized for 2000kcal, expressed as percentage of the Daily Recommended Intake. Red line shows 100% adequacy



Conclusion/discussion

- **10 people can consistently be fed throughout the year** with 40% vitamin D imported into the system equating estimates for caloric production of conventional systems (Cassidy, West, Gerber, & Foley, 2013).
- Dutch Diet takes up 0.69 ha per person (Gerbens-Leenes & Nonhebel, 2005), the food forest is able to feed substantially more people per area requiring only 0.09-0.11 ha per person amounting to **land use reduction of 83-86%**, beyond what is expected for switching to a plant base diet alone (60%)
- The average Dutch is limiting in: fibre, folate, iron, potassium, vitamin B2 and D (RIVM, 2016), all of which aside from vitamin D can be amply supplied in food forests, potentially indicating a role

Future work

- the population with increased implementation
- How do agroforestry systems contribute to food security and biodiversity goals in Europe?

References

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