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A Systematic Review of Sustainable Agriculture in the Netherlands

Abstract

As society comes to terms with the impacts — both current and impending — of anthropogenic climate change, we find that promoting sustainable agriculture is an issue of the utmost importance. Decreases in available resources coupled with increases in population growth will give rise to global agricultural disaster by the midpoint of the century, causing mass hunger and famine. The Netherlands is universally respected as an innovator of sustainable agriculture, thus probing us to determine how other countries may adopt Dutch farming practices in order to decrease our resource use while increasing our food output. In our analysis, we reviewed a variety of academic articles and studies on this topic. Our sources included those provided in the Sustainable Cities course and additional studies found through the online database Web of Science. We found that policy changes, innovative practices, and urban or peri-urban farming were all pivotal elements of the Netherlands' successful approach to sustainable agriculture. Dutch efforts prioritize closing the cycle of resource consumption in order to make agriculture-self sustaining, all while producing significant crop yields. The main implication of our findings is that other developed countries should mimic the aforementioned strategies employed by the Netherlands in order to decrease resource use while increasing food outputs. While governments won't be able to adopt all of these practices, simply pushing their agricultural sector towards sustainable intensification may yield great, impactful amendments to flawed systems that can help combat climate change and world hunger.

Introduction

The Netherlands exhibits an incredibly impressive agricultural system, being globally recognized as a huge producer of goods despite using less land and resources compared to other top producers, such as the United States. The Dutch are the world's top exporters of tomatoes, potatoes, and onions despite only using a fraction of the land and resources used by other top producers. A common farming saying in the Netherlands is "twice as much food using half as many resources," an ideology that prioritizes "precision farming" and sustainable agriculture through novel, technologically advanced initiatives (Viviano 2017). Dutch farming practices simultaneously prioritize environmental sustainability, global food trends, and local economic growth while still being an international superpower in the sphere of agriculture.

In reviewing the following sources, we ask ourselves: what agricultural practices enable the Netherlands to produce more food while using less resources than other countries? In answering this question, we wish to consider how Dutch policies and strategies may be implemented in other countries to generate similar results in decreased resource use and increased food output. Our analysis was completed within the context of anthropogenic climate change, a global issue that threatens the health and safety of billions in regard to food security. Thus, an answer to our research question can prove extremely useful in mitigating the impacts of agricultural disaster as a result of anthropogenic climate change.

Review of Literature

A. Agriculture in the Netherlands

The Netherlands is globally respected for its fruit and vegetable outputs. By way of illustration, the Dutch are the top exporters of potatoes and onions, the second largest global exporter of vegetables in terms of value, and their tomato industry is the number one global producer in yield — resulting in more than a third of all global trade in vegetable seeds coming from the Netherlands (Viviano 2017). The Dutch are further admired for their environmentally sustainable agricultural practices, these being the result of scale enlargement and agricultural intensification that were generated by political regulations and market forces (Runhaar 2017).

B. Anthropogenic climate change

Anthropogenic climate change is a catastrophic phenomena in which human activity is causing the Earth's temperature to rise at a rapid pace. This global issue threatens the health and safety of billions in regard to food security in how it decreases the amount of resources available for agriculture while the human population undergoes simultaneous, substantial growth in the coming decades. As the world's population is expected to reach nearly 10 billion by the year 2050 while resultantly consuming more water and fossil fuels, hunger will likely become the biggest problem of the century (Viviano 2017). In conjunction with this expected growth amidst greater resource depletion are the disastrous effects of climate change, with natural disasters giving rise to more and more famines across the world — especially impacting developing countries and those living in poverty. Thus, the need for better, more efficient farming techniques that produce more food while consuming less resources is greater than ever.

C. Closing the cycle of resource use

In order to mitigate the negative impacts of climate change, all industries must "transition towards a more sustainable system which eventually achieves circularity and climate-neutrality in all sectors, including agriculture" (Gonzalez-Martinez et al. 2021). Given these concerns, the Dutch government has invested considerable resources in facilitating a transition towards a fully circular economy by 2050. Within this ambition comes another: a vision of circular agriculture. This entails examining the pitfalls of the current agricultural supply chain and fixing these issues so that food production practice may be self-sustaining. Strategies include the regeneration, recycling, and minimization of materials such as soil, water, and energy (Dagevos and de Lauwere 2021).

D. Focus on research and collaboration

In working towards increased agricultural yields while using less resources, scientists and farmers must work together to devise a variety of sustainable practices that seek to limit the flow of resources such as water, energy, and nutrients. Climate change mitigation and efforts towards circular agriculture require a multi-dimensional outlook and collaborative efforts from a variety of stakeholders in the food system, including government officials, scientists, and farmers (Gonzalez-Martinez et al. 2021). This is often a daunting task given the different desires and needs from each group. Thus, in order for sustainable practices to first be created and then put into actual use, individuals of varying professions and backgrounds must come together to brainstorm ideas. Diverse perspectives, common goals, and shared values are vital in order to find answers to climate-related problems while simultaneously closing the cycle of resource use (Viviano 2017).

Methodology

A. Eligibility Criteria

In seeking out our sources, we specified our inclusion criteria as a scholarly article, journal, or study that was published during or after 2016. Simultaneously, our exclusion criteria included sources that were published before 2016 or that did not have a full copy or excerpt available for examination.

B. Information Sources

In finding sources to perform this study, we first collected and analyzed the articles provided in class. Next, we consulted the University of Pittsburgh Library system's "A to Z Databases" in order to find studies and literary reviews to supplement the sources previously provided. In using this database, we first entered "Environmental Studies" into the "Subject" field of the search engine. From there, we discovered a database called Science Citation Index, or Web of Science. From the options listed under the broad scope of environmental studies, this site was the most relevant as well as most accessible of the listed databases, and thus the only database we used in finding our sources.

C. Search Strategy and Selection Process

We used a series of key terms in order to find our sources from the Web of Science database. Our search entries included: "sustainable agriculture in the Netherlands"; "sustainable Dutch agriculture"; "sustainable agriculture in Holland." Sources were then selected based on the research question and analyses present in the abstract of each study. We looked for sources that focused on novel approaches to agriculture that prioritized climate change mitigation and food

security in the Netherlands. Roughly 15 sources were screened for the review and only four were selected for inclusion.

D. Study Risk of Bias Assessment

Given that many of our sources were derived from course material, this selection exhibits the inherent bias of being chosen for academic analysis as a class, not for a research-specific study. Bias could have been further present in our search terms used within the database, potentially narrowing the results to specific disciplines or studies conducted in too narrow a sphere. In addition, only one database was used for finding these sources, potentially limiting our ability to discover and analyze more relevant reviews and studies.

Findings

A. Policy changes

The implementation of sustainable farming practices that work towards circular agriculture is an inherently political problem. For one, “new cultivation methods can’t be implemented [without] public funding” (Viviano 2017). Since the Dutch government made a commitment producing “twice as much food using half as many resources” in 2000, many farmers have reduced their dependence on water by as much as 90% while also decreasing their use of chemical pesticides on plants and antibiotics on poultry and livestock (Vivano 2017). Policy changes that provide substantial funding towards agricultural research, financial incentives such as subsidies for farmers who employ circular practices, and impose regulations regarding greenhouse gas emissions and land use are necessary to create a sustainable system that can effectively mitigate

the impacts of climate change by decreasing resource consumption while simultaneously enabling practices that generate greater outputs (Gonzalez-Martinez et al. 2021).

Specifically, there are two central policy dimensions to consider within a political approach. First, "there is the design and selection of policy measures that contribute to making new emission-reducing innovations available [thus helping] farmers to adopt such measures or make investments in new technologies" (Gonzalez-Martinez et al. 2021). For example, the construction of low-emission stables or driverless drones that assess topsoil quality. Additionally, there must be "policy measures facilitating the structural adjustments in the animal sectors" (Gonzalez-Martinez et al. 2021). This could include the reduction of livestock numbers or legal restraints on greenhouse gas emissions. While both dimensions working in conjunction are crucial to closing the resource cycle, the former is more important for generating greater outputs while the latter is slightly geared more towards environmental sustainability.

B. Innovative practices

Scientific research and experimentation is another crucial component in shifting agriculture towards circularity (Dagevos and de Lauwere 2021). The Dutch are known for their commitment to agricultural research, particularly at Wageningen University and Research (WUR), and other countries would significantly benefit from having universities or programs devoted to similar studies. Some recent practices devised by researchers and employed in the Netherlands include creating greenhouse complexes with climate-control measures using heat generated from geothermal aquifers, employing drones, driverless tractors, and quadcopters that assess the health of plants and soil, generating fertilizer from fish waste, turning old vines from tomato plants into

packaging materials, and using predatory mites, nematodes, and other creatures in place of pesticides (Viviano 2017).

Furthermore, many Dutch farmers are developing new sustainability-oriented practices to simply sell their goods. Many are choosing "to specialize, differentiate, or diversify when adopting a marketing strategy" (van Der Schans 2010). By specializing in one or few products, farmers can focus on their means of operations and reduce costs of production, processing, and distribution. Farms close to cities also have a competitive advantage as well in providing social services to customers, as transport is very accessible and efficient and can lower their greenhouse gas emissions (van Der Schans 2010).

C. Urban and peri-urban agriculture

Urban agriculture is seen by many as a potential solution against "environmental problems associated with large-scale and long-distance food chains […] lack of sensory quality and diversity of foods produced in the conventional system, and a general lack of trust in food coming from impersonal chains and anonymous origins" (van Der Schans 2010). People want to eat fresh and tasty food, bring about social change and economic regionalization, and improve the sustainability and resilience of metropolitan food systems — and consuming goods from local farms is an excellent way to accomplish these goals. Urban agriculture thus enables a transition towards "sustainable and multifunctional agriculture with a focus on nature quality and landscape management and expansion of farm activities" (Schulp et al. 2022).

Additionally, with global urbanization and population increases come increased human demand for land surfaces and resources. As most cities are built on viable farmland, land policy changes that support urban and peri-urban farming help contain urban sprawl and instead promote compact city planning. Sidewalks, concrete roads, and buildings are instead replaced with sustainable vegetable and dairy farms that help to amplify the world's food production capacity while simultaneously limiting greenhouse gas emissions and absorbing urban heat (Girardet 2000).

Discussion

A. Interpretation

In terms of policy changes, it is up to individual governments to determine the most effective combination of policy measures and restrictions to achieve sustainable, circular agriculture. Policies must prioritize the sustainable intensification of agriculture — "the development and subsequent adoption of emission-reducing technologies and management measures, reducing livestock numbers and extending agro-forestry activities, are key elements that could favor the transition towards a sustainable pathway" (Gonzalez-Martinez et al. 2021). That being said, policy changes are a significant and necessary element to enacting sustainable farming practices that close the cycle of resource use. Our analysis of Dutch practices affirms the belief that effective climate change mitigation may only occur through government involvement and deliberate policy changes that support sustainable intensification (Schulp et al. 2022).

The study and implementation of innovative practices occurs alongside policy changes. Proper resources must be allocated to research universities and institutions that focus on developing

novel techniques to create a circular agricultural sector, including funding as well as researchers willing and motivated to find solutions to issues created by climate change. We must think outside of the box if we wish to mitigate the impending agricultural disaster caused by climate change, giving special attention to techniques that assess soil nutrients and close the cycle of resource use (Viviano 2017).

In regards to urban agriculture, the aforementioned Dutch practices allow for efficient, streamlined access to fresh food while supporting local businesses, thus supplementing a region's economy, supporting small business owners, and using less resources in product transportation (Schulp et al. 2022). Where traditional Dutch agriculture has been geared towards global export markets, urban and peri-urban agriculture is oriented towards city dwellers living close to the farms in question. Moreover, the Dutch government sees urban farms not merely as a means of improving access to fresh food, but also as a bridge between city dwellers who know little about food production and farmers who feel misunderstood and undervalued, thus supporting citizens' well-being and expansion of agricultural knowledge. Urban growth is no longer a threat to Dutch farmers — who in the past may have faced issues such as pressure on farmland prices due to urban sprawl — but instead an opportunity to take advantage of direct sales, volunteer labor, and specialty urban markets while limiting urban sprawl and engaging in compact city planning (van Der Schans 2010).

B. Limitations

One significant limitation to revolutionizing agriculture — as a means of combating hunger and climate change — is the ability for the government to enact significant policy changes. While

some may believe that the government is not doing enough, others often feel that the government is overstepping — and the Dutch Ministry of agriculture is not immune to this criticism either (Dagevos and de Lauwere 2021). In practice, many ambitions may be inapplicable, unfeasible, or simply too expensive for farmers to even accomplish.

In conjunction with these concerns, many farmers worry that the regulatory pressures of policy changes may inhibit the agricultural playing field and create unfair competition with producers in other countries as a result of overproduction of agricultural products and decreased prices on goods (Schulp et al. 2022). Even amidst financial compensation or other forms of funding, many farmers further struggle to participate in sustainable agricultural practices as they must often pay for more nature-inclusive farming as part of sustainable intensification efforts (Runhaar 2017). The extent to which Dutch, and other, consumers are willing to pay for more sustainably farmed products is also unclear. Moreover, most farmers do not believe that it is possible for their agricultural practices to become 100% circular given their experience in the farming industry (Dagevos and de Lauwere 2021).

In addition, there is often opposition to urban agriculture as a result of public health and urban planning issues, such as potential for water pollution and soil contamination. While these concerns are valid, research regarding adverse effects on public health is often exaggerated, thus necessitating the need for further research (Girardet 2000).

C. Implications

The interpretation of our findings suggests three main methods that countries may adopt in order to mimic the Netherlands' success as a global agriculture superpower while prioritizing sustainable intensification: policy changes, innovative practices, and urban agriculture. Before the two latter tactics may occur, governments must first enact policy changes to enact sustainable intensification — that is, revolutionizing farming practices to be more eco-friendly while producing greater outputs, especially within the context of closing the cycle of resource use. Policies must be put into action that support research on novel farming techniques, the creation of urban farms through land use, and subsidies for farmers who adopt sustainable and urban or peri-urban practices. While absolute circularity of agricultural practices is nearly impossible, by observing and adopting Dutch policies, research methods, and farming techniques, other countries may decrease their carbon footprint while simultaneously producing more food.

Conclusion

At the conclusion of our research, we persist in our great admiration for Dutch farming practices that promote sustainable intensification and experimentation. While many countries are hesitant to adapt their agricultural sectors to mitigate the impacts of climate change, the Netherlands provides authentic evidence to support agricultural innovation. We determined the three central aspects of the Dutch approach as adaptations to land use and agriculture policy, engagement in research on novel farming techniques, and installation of urban and peri-urban farms. If other countries commit to these areas, they have the potential to — in accordance with current data from the Netherlands — halve their resource consumption while doubling their crop production.

References

Dagevos, H. and de Lauwere, C. 2021. Circular business models and circular agriculture: Perceptions and practice of Dutch farmers. *Sustainability*, 13, 1282. Doi: 10.3390/su13031282.

Girardet, H. 2000. Urban Agriculture and Sustainable Cities. *Deutsche Stiftung fur Internationale Entwicklung (DSE), Zentralstelle fur Ernahrung und Landwirtschaft*, 33-39.

Gonzalez-Martinez, A.R. et al. 2021. Aligning agricultural production and environmental regulation: An integrated assessment of the Netherlands. Land Use Policy, 105. Doi: 10.1016/j.landusepol.2021.105388.

Runhaar, H. 2017. Governing the transformation towards "nature-inclusive" agriculture: Insights from the Netherlands. *International Journal of Agricultural Sustainability*, 15:4, 340-349. doi: 10.1080/14735903.2017.1312096.

Schulp, C. et al. 2022. The role of different types of actors in the future of sustainable agriculture in a Dutch peri-urban area. *Environmental Management*. Doi: 10.1007/s00267-022-01654-3.

van Der Schans, J.W. 2010. Urban agriculture in the Netherlands. *Urban Agriculture Magazine*, no. 24.

Viviano, F. 2017. This tiny country feeds the world. *National Geographic Magazine*.