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# Reporting on marginal lands for bioenergy feedstock production - a modest proposal

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---PREPRINT In press 2014, *BioEnergy Research* ---

**Abstract** Growing bioenergy feedstocks can provide a long-term sustainable production system for marginal land resources and is essential for minimizing food vs. fuel competition for prime cropland resources. However, the term “marginal” is too often used in research reports without being defined. We here suggest that clearly specifying the biophysical factors and agroeconomic context contributing to marginality will greatly enhance the utility and comparability of published research.

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## *Using marginal lands for bioenergy feedstock production*

Discussions of renewable bioenergy feedstock production frequently cite the use of marginal agricultural lands in order to minimize food vs. fuel competition on prime farmlands. However, when reviewing studies referencing marginal lands, it is evident that “marginal” is often used in a subjective sense for less-than-ideal lands without sufficient specificity. This vague and subjective use of “marginal” to describe sub-prime land is not new: in 1932, Peterson and Galbraith [1] wrote, “In its various applications, the word marginal has perhaps been too glibly used in recent years. As frequently employed, the phrase ‘marginal land’ is little more than a convenient expression for land that is barren, rough, inaccessible, or possessed of other undesirable characteristics or relationships.”

## *Marginality is relative*

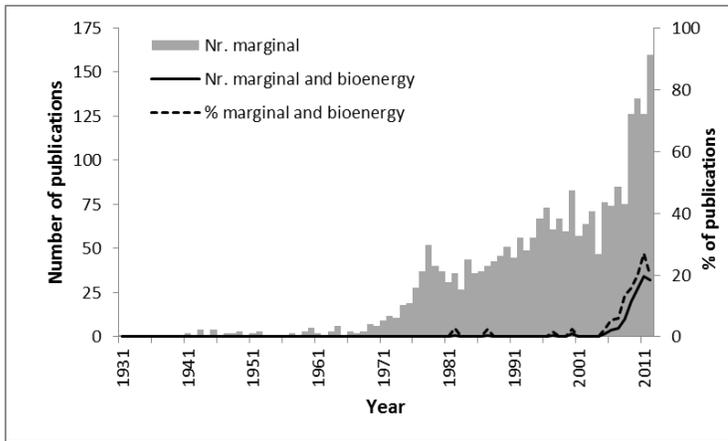
As Peterson and Galbraith [1] point out – and many others since – the term marginal is an *economic* term for land that is at the *margins of production*, where potential returns at best break even with the costs of production. This contrasts with *submarginal* land where any attempt at production will clearly be a losing proposition. The fact that marginal is an economic term means that it is defined by the local economic context, which has important implications. First, marginal is relative with respect to location. A soil profile with a set of specific biophysical characteristics reported as “marginal” in the US corn belt may be one of the better soils available in another context. Second, evolution of the economic evaluation framework over time may change what constitutes “marginal”. For example, some soils in New York State initially used for dairy farming – and then abandoned for decades – now support thriving wineries. The trebling of corn grain prices during recent years has brought many idled lands back into production, including over 500,000 ha in the western corn belt of the US [2].

As Tolstoy famously observed in the opening sentences of *Anna Karenina*, happy families are all alike; every unhappy family is unhappy in its own way. A similar statement might be applied to soils. Everyone knows a prime soil when they see it, a happy reflection of the almost-mythical soil described on the back of every garden seed packet ever sold: deep, friable, fertile, well-watered, well-drained, weed-free soil in a sunny location. In contrast, there are many factors that, alone or in combination, can render a soil marginal for an intended use: too wet, too dry, too steep, too stony, too barren, too shallow, too remote, and even too parcelized. These specific terms provide far more insight than a blanket assessment of *marginal*, but in many cases this useful information is not reported.

**Increasing interest in marginal lands; definitions vary widely**

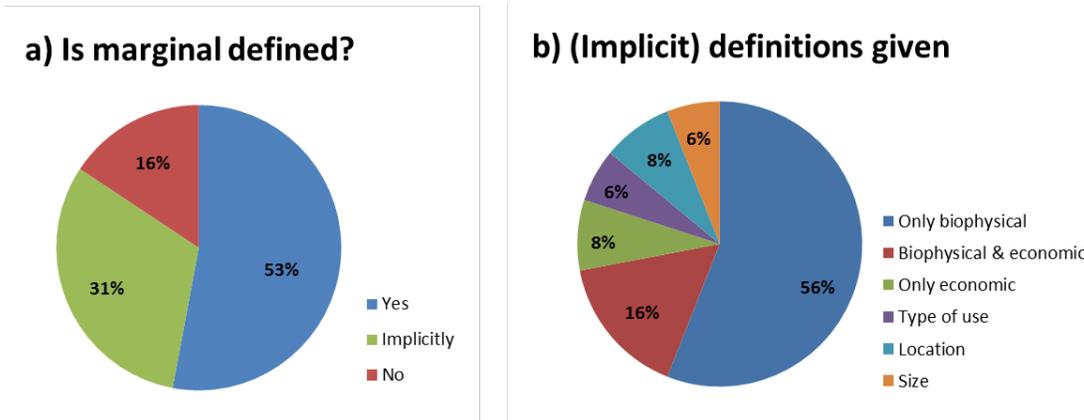
Since the 1930’s, use of the term ‘marginal land(s)’ or ‘marginal soil(s)’ in the scientific literature has steadily increased based on our review of the literature (Fig. 1), although prior to 2005 this increase mainly resulted from subjects other than bioenergy. More recently, there has been rising interest in bioenergy from marginal lands, given the increasing number of citations containing both “marginal land” and “bioenergy” (Fig. 1), yet the use of marginal often remains vague and subjective. Definitions of marginality can further vary by academic discipline [3], and often neglect socioeconomic dimensions [4].

In addition to counting all English-language articles containing “marginal land(s)” or “marginal soil(s)” in their topic in the ISI Web of Knowledge (Fig. 1), we reviewed all 51 retrievable English-language articles published between 2008 and 2012 that had these search terms in their title (see Electronic Supplementary Material). Only half of these 51 articles reviewed provided a clear and explicit definition of marginal (Fig. 2a), while a third provided only implicit definitions which could be inferred from the context. The remainder (16% of total articles) provided no definition of their use of marginal, the most extreme example being a paper where marginal appeared only in the title (see Electronic Supplementary Material).



**Fig. 1** Number of ISI-cited publications with “marginal land(s)” or “marginal soil(s)” in the topic (grey bars, 2242 total), and publications also referencing bioenergy in the topic (solid line, 139 total). The dashed line indicates the percent of publications citing both marginal lands/soils and bioenergy.

Of the articles providing explicit or implicit definitions of marginality, 56% defined it solely in terms of biophysical characteristics (Fig. 2b) despite the fact that marginality is dependent on the economic context. Only 16% included both biophysical and economic contexts, and 8% included solely an economic context. The remaining 20% used the term marginal generally to indicate the type of use (i.e., intensive vs. extensive), location, or scale.



**Fig. 2** Review of 51 ISI Web of Knowledge-cited articles containing marginal land(s) or marginal soil(s) in the title; a) percent of articles that define the word ‘marginal’, and b) classes of implicit or explicit definitions given for the word ‘marginal’.

### ***Clearly define marginal***

Given these results, our modest proposal is simply that *authors reporting on marginal soils and marginal lands clearly state the context, definition, and specifics of marginality*. For example, in our forthcoming publications on our research on perennial grass bioenergy feedstocks in upstate New York, we will describe our field site soils as marginal due to seasonal and recurring wetness caused by poor internal drainage that limits trafficability and prevents reliable cultivation of annual row crops such as corn, soybean and small grains. Reporting of soil series and related taxonomic information is essential for describing the soils in question, but this alone is not necessarily sufficient, given that marginality is not a fixed quantitative threshold but rather a relative ranking that reflects the effect of biophysical characteristics on the costs and sustainability of production in a given agro-economic context. Additionally, for studies covering large areas, it may not be feasible to report on the thousands of taxonomic units of soils. Further highlighting the specific physical characteristics most critical for the production system(s) being used as the basis of evaluation can also be helpful. A sustained timeframe for evaluation of marginality is typically assumed in order to exclude cases where short-term profitability could be realized only through market price aberrations and/or unsustainable exploitation of the soil base [5].

Clear specification of both the biophysical factors and the present agro-economic context will better inform the reader, aid in the re-assessment of findings in light of different crops or changing economic conditions, and will facilitate broader comparisons of studies conducted on marginal lands. Given the essential role of marginal lands in bioenergy production, the long-term usefulness of research publications can be improved by clearly defining both the biophysical and economic contexts that render their study sites marginal.

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### ***Acknowledgments***

This research was supported in part by the US Department of Agriculture through the National Institute of Food and Agriculture Sustainable Bioenergy Grant No. 2010-03869, and by funding from the North Central Regional Sun Grant Center at South Dakota State University through a grant provided by the US Department of Energy Bioenergy Technologies Office under award number DE-FC36-05GO85041.

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### ***References***

1. Peterson GM, Galbraith J (1932) The concept of marginal land. *Journal of Farm Economics* 14 (2):295-310
2. Wright CK, Wimberly MC (2013) Recent land use change in the Western Corn Belt threatens grasslands and wetlands. *Proceedings of the National Academy of Sciences*. doi:10.1073/pnas.1215404110
3. Liu TT, McConkey BG, Ma ZY, Liu ZG, Li X, Cheng LL (2011) Strengths, Weaknesses, Opportunities and Threats Analysis of Bioenergy Production on Marginal Land. *Energy Procedia* 5 (0):2378-2386. doi:10.1016/j.egypro.2011.03.409
4. Nalepa RA, Bauer DM (2012) Marginal lands: the role of remote sensing in constructing landscapes for agrofuel development. *The Journal of Peasant Studies* 39 (2):403-422. doi:10.1080/03066150.2012.665890
5. Gopalakrishnan, G., MC Negri, SW Snyder (2011) A novel framework to classify marginal land for sustainable biomass feedstock production. *Journal of Environmental Quality* 40:1593–1600. doi:10.2134/jeq2010.0539