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SUSTAINABILITY ASSESSMENT OF BIOFUEL FEEDSTOCK OPTIONS IN GHANA

（ガーナにおけるバイオ燃料原料のサステナビリティ評価）

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ABSTRACT

Biofuel feedstock production has been promoted across different areas of Sub-Saharan Africa to boost socioeconomic development and energy security. However, biofuel crop production can have important implications for land use change, biodiversity loss, poverty alleviation, livelihoods and food security at the local level.

Ghana was one of the countries that experienced a large expansion of the biofuel crop jatropha between 2008 and 2013. By 2013, most of these projects had collapsed having had important environmental and socioeconomic impacts locally. Since then there have been scattered discussions about the future of biofuels in the country either using jatropha or other feedstocks such as sugarcane and oil palm.

To inform such discussions it is important to understand what have been the drivers of the widespread jatropha collapse and the local sustainability impacts of different feedstock options. However, despite some scattered literature, no study has undertaken a comprehensive assessment of the different reasons that led to jatropha collapse around Ghana or elsewhere in sub-Sahara Africa. Furthermore, few studies have adopted a holistic approach for the assessment of the local impacts of biofuel feedstock production across the three pillars of sustainability (environment, social, and economic), in Ghana or other parts of sub-Sahara Africa.

This study aims to assess the local sustainability impacts of different biofuel feedstock options that have either been promoted or hold potential for biofuel production in Ghana. The study specifically seeks to (a) understand the drivers of biofuel feedstock production in Ghana and map out the current institutional arrangements, (b) identify the reasons for the widespread collapse of the jatropha sector and document the land acquisition processes, (c) understand and quantify the local sustainability impacts of different feedstock options in Ghana, (d) identify and

explain how different local conflicts emerge in areas of feedstock production, and the local acceptability of biofuels feedstock options in Ghana.

To address these complementary objectives, the study adopts a sustainability science approach to synthesize existing knowledge and frame the empirical assessment at local scale using various case studies. These include six collapsed large jatropha plantation (in Kadelso, Ahinakom, Kobre, Lolito, Adidome and Kpachaa) and three operational feedstock projects: a large jatropha plantation (in Yeji), a smallholder sugarcane project (in Dabala) and a hybrid oil palm project that contains a large core plantation surrounded by smallholders (in Kwae).

For objective (a), an extensive literature review and policy analysis were undertaken to understand the structure of the biofuel sector in Ghana and the interactions between key stakeholders.

For objective (b), 21 expert interviews, six focus group discussions, three participatory community mapping exercises, and 201 rapid household surveys were conducted around the six collapsed jatropha projects to understand the drivers of jatropha expansion, institutional arrangement, land acquisition processes, reason of collapse and local sustainability impacts.

For objective (c), the selected study projects reflected the main feedstock options (i.e. sugarcane, jatropha and oil palm) and modes of production (i.e. smallholder, plantation and hybrid systems) across the country's three agro-ecological zones. In total around 850 household surveys captured a series of social and economic impacts (food security, poverty, livelihood and energy poverty). Remote sensing analysis and ecological surveys were undertaken to assess key environmental impacts related to carbon stock change and biodiversity loss.

For objective (d), community perspectives were elicited through 80 local interviews and 15 focus group discussions around the three operational projects to understand the different local conflicts related to feedstock production across the collapsed and operational projects.

For objective (a), the study verifies the actual land acquired for biofuel projects, the amount of foreign direct investment for biofuel projects and the connections between the main stakeholders in the sector.

For objective (b), the study identifies a number of reasons behind the failure of the jatropha sector such as poor business planning, poor land administration, low jatropha productivity, local community conflicts, and obstacles posed by civil society The findings indicate the systemic nature of jatropha collapse, as these factors often worked synergistically to catalyze the collapse of many jatropha projects in Ghana. However, land-related issues are central to almost all of these drivers of collapse. The unconstructive involvement of chiefs during the land acquisition processes was a common theme behind the collapse of many projects.

For objective (c), the impact assessment of the collapsed projects suggests that a significant increase in jobs and income occurred during the operational phase of these projects. After the collapse, there were significant decreases in rural employment and income in all six sites.

For the operational projects, at the landscape level, most feedstock options impact negatively the environment in terms of carbon stocks and biodiversity, albeit to different extents. The only single exception is a net carbon gain associated with the cultivation of oil palm in the Kwae site. For socioeconomic impacts at the household level, feedstock producers (i.e. smallholders) in oil palm and sugarcane sites are better off than other groups in their respective sites in terms of food security, poverty and livelihood. In addition, workers are either worse off

or at similar status with non-involved groups at their respective sites. Positive impacts are yet to be observed in the jatropha site as the non-involved group is better than those involved.

For objective (d), plantation modes of feedstock production are characterized by land-related conflicts in terms of land rights disputes and compensation. Such issues manifested both around the operational and collapsed plantation sites. While there is currently considerable scepticism among stakeholders about the future of biofuel feedstock production in Ghana (and especially of jatropha), there is still some interest especially for oil palm and sugarcane as reflected in community surveys and recent government policies.

From a policy perspective, any interest in reviving the collapsed jatropha sector or promoting other feedstock options must give considerable attention to: (a) addressing the impediments of land administration, (b) conducting agro-ecological zoning and proper site selection, (c) understanding and assessing the expected sustainability trade-offs, (d) establishing viable feedstock markets, (e) improving community participation in project design, and (f) developing appropriate guidelines for certification.

(Word count: 995)

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LIST OF ABBREVIATIONS

AG	Above Ground
BG	Below Ground
CEHRT	Centre for Environment and Health Research and Training
CICOL	Civil Society Coalition on Land
CREMA	Community Resource Management Area
CSI	Coping Strategy Index
CSO	Civil Society Organizations
DB_NS	Dabala Non- Involved

DB_S	Dabala Sugarcane smallholder
DBH	Diameter at Breast Height
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency
FCS	Food Consumption Score
FDI	Foreign Direct Investment
FGD	Focus Group Discussion
GHG	Greenhouse Gas
GIPC	Ghana Investment Promotion Centre
GOPDC	Ghana Oil Palm Plantation Development Corporation
HFIAS	Household Food Insecurity Access Scale
KW_C	Kwae Non-Involved
KW_GW	Kwae GODPC Worker
KW_ID	Kwae Independent Grower
KW_OG	Kwae Outgrower
LCA	Life Cycle Analysis
LSLA	Large-Scale Land Acquisition
LUCC	Land Use/Cover Change
MEPI	Multidimensional Energy Poverty Index
MoFA	Ministry of Food and Agriculture
MPI	Multidimensional Poverty Index
NGO	Non-Governmental Organization
NTFPs	Non-Timber Forest Projects

SDGs	Sustainable Development Goals
SOC	Soil Organic Carbon
SSA	Sub-Saharan Africa
TCPD	Town and Country Planning Department
YJ_JC	Yeji Jatropha Non-Involved
YJ_JPW	Yeji Jatropha Permanent Worker
YJ_JSW	Yeji Jatropha Seasonal Worker

LIST OF TERMS

Community Resource Management Area: this is a mechanism of natural resource management at the landscape level where communities put lands together for conservation purposes.

Drivers of Collapse: refers to the factors that have led to the total halting/failure of jatropha activities nationally and locally.

Independent Grower or Smallholder: is a person who undertakes personal cultivation of feedstock for subsistence and has a choice to sell to any market depending on price signals.

Large-scale Land Acquisition: this is the acquisition of any tract of land larger than 200 hectares (ha) per a single land deal.

Non-Involved: this person is a subsistence farmer within feedstock production area but not involved in the feedstock value chain.

Outgrower: this is a person who is contracted by an oil palm company to cultivate oil palm and sell back the fresh fruit bunches to the company

LIST OF UNITS OF MEASUREMENT

cm	centimetre
GH¢	Ghana Cedis
ha	hectares
kg	kilogram
Km^2	square kilometers
m	meters
$t\ ha^{-1}$	tonnes per hectare
US$	United States dollars

CITED REFERENCES

Acheampong, E., and Campion, B. 2014. The Effects of Biofuel Feedstock Production on Farmers' Livelihoods in Ghana: The Case of Jatropha curcas. *Sustainability*, *6*7, 4587–4607. http://doi.org/10.3390/su6074587

Acheampong, E., and Campion, B. B. 2013. Socio-economic impact of biofuel feedstock production on local livelihoods in Ghana. *Ghana Journal of Geography*, *5*, 1–16. http://doi.org/10.13140/2.1.3133.5048

Achten, W. M. J., and Verchot, L. V. 2011. Implications of Biodiesel-Induced Land-Use Changes for CO2 Emissions: Case Studies in Tropical America, Africa, and Southeast Asia. *Ecology and Society*, *16*4, art14. http://doi.org/10.5751/ES-04403-160414

Achten, W. M. J., Maes, W. H., Reubens, B., Mathijs, E., Singh, V. P., Verchot, L., and Muys, B. 2010. Biomass production and allocation in Jatropha curcas L. seedlings under different levels of drought stress. *Biomass and Bioenergy*, *34*, 667–676. http://doi.org/10.1016/j.biombioe.2010.01.010

Achten, W. M. J., Vandenbempt, P., Almeida, J., Mathijs, E., and Muys, B. 2010. Life Cycle Assessment of a Palm Oil System with Simultaneous Production of Biodiesel and Cooking Oil in Cameroon. *Environmental Science and Technology*, *44*12, 4809–4815. http://doi.org/10.1021/es100067p

ActionAid Ghana. 2012. *Land Grabbing, Biofuel Investment And Traditional Authorities In Ghana*. Accra.

Adanes Consult. 2011. *Final Environmental Impact Assessment: proposed jatropha farm project: Adidome*. Accra.

Agyare, A. K., Murray, G., Dearden, P., and Rollins, R. 2015. Understanding inter-community performance assessments in community-based resource management at Avu Lagoon, Ghana. *Environment, Development and Sustainability*, *17*6, 1493–1508. http://doi.org/10.1007/s10668-014-9617-7

Aha, B., and Ayitey, J. Z. 2017. Biofuels and the hazards of land grabbing: Tenure insecurity and indigenous farmers' investment decisions in Ghana. *Land Use Policy*, *60*, 48–59. http://doi.org/10.1016/j.landusepol.2016.10.012

Ahmed, A., and Gasparatos, A. 2016. Rapid Sustainability Appraisal of Collapsed Jatropha Projects in Ghana Using Local Community Perceptions: Methodological Implications for Sustainability Science. In *Sustainability Science: Field Methods and Exercises* [Esteban, M., Akiyama, T., Chiahsin, C., and Ikeda, I. (eds.)]. Springer, Berlin pp. 199–227.

Ahmed, A., Campion, B. B., and Gasparatos, A. 2017a. Biofuel development in Ghana: policies of expansion and drivers of failure in the jatropha sector. *Renewable and Sustainable Energy Reviews*, *70*, 133–149. http://doi.org/10.1016/j.rser.2016.11.216

Ahmed, A., Jarzebski, M. P., and Gasparatos, A. 2017b. Using the ecosystem service approach to determine whether jatropha projects were located in marginal lands in Ghana: Implications for site selection. *Biomass and Bioenergy*. http://doi.org/10.1016/J.BIOMBIOE.2017.07.020

Ahmed, A., Campion, B. B., and Gasparatos, A. 2018a. Towards a classification of the drivers of jatropha collapse in Ghana elicited from the perceptions of multiple stakeholders. *Sustainability Science*, 1–25. http://doi.org/10.1007/s11625-018-0568-z

Ahmed, A., Kuusaana, E. D., and Gasparatos, A. 2018b. The role of chiefs in large-scale land acquisitions for jatropha production in Ghana: insights from agrarian political economy. *Land Use Policy*, *75*, 570–582. http://doi.org/10.1016/J.LANDUSEPOL.2018.04.033

Ahmed, A., Lawson, E. T., Mensah, A., Gordon, C., and Padgham, J. 2016. Adaptation to climate change or non-climatic stressors in semi-arid regions? Evidence of gender differentiation in three agrarian districts of Ghana. *Environmental Development*, *20*, 45–58. http://doi.org/10.1016/j.envdev.2016.08.002

Ajanovic, A. 2011. Biofuels versus food production: Does biofuels production increase food prices? *Energy*, *36*4, 2070–2076. http://doi.org/10.1016/j.energy.2010.05.019

Alkire, S., and Foster, J. 2011a. Counting and multidimensional poverty measurement. *Journal of Public Economics*, *95*7–8, 476–487. http://doi.org/10.1016/J.JPUBECO.2010.11.006

Alkire, S., and Foster, J. 2011b. Understandings and misunderstandings of multidimensional poverty measurement. *The Journal of Economic Inequality*, *9*2, 289–314. http://doi.org/10.1007/s10888-011-9181-4

Alkire, S., and Santos, M. E. 2011. *Training material for producing national human development reports : the Multidimensional Poverty Index MPI: OPHI research in progress 31a*.

Alkire, S., and Santos, M. E. 2014. Measuring Acute Poverty in the Developing World: Robustness and Scope of the Multidimensional Poverty Index. *World Development*, *59*, 251–274. http://doi.org/10.1016/j.worlddev.2014.01.026

Alkire, S., Foster, J. E., Seth, S., Santo, M. E., and Roche, J. M. 2015. *Multidimensional poverty measurement and analysis. 4 Counting approaches definitions, origins, and implementations*. Oxford Poverty and Human Development Initiative.

Alkire, S., Foster, J. E., Seth, S., Santos, M. E., Roche, J. M., and Ballon, P. 2015a, January 15. Multidimensional Poverty Measurement and Analysis: Chapter 5 – the Alkire-Foster Counting Methodology.

Alkire, S., Foster, J. E., Seth, S., Santos, M. E., Roche, J. M., and Ballon, P. 2015b, January 31.

Multidimensional Poverty Measurement and Analysis: Chapter 8 – Robustness Analysis and Statistical Inference. Oxford: Oxford University Press.

Alo, C. A., and Pontius, R. G. 2008. Identifying Systematic Land-Cover Transitions Using Remote Sensing and GIS: The Fate of Forests inside and outside Protected Areas of Southwestern Ghana. *Environment and Planning B: Planning and Design*, *35*2, 280–295. http://doi.org/10.1068/b32091

Anderman, T. L., Remans, R., Wood, S. A., DeRosa, K., and DeFries, R. S. 2014. Synergies and tradeoffs between cash crop production and food security: a case study in rural Ghana. *Food Security*, *6*4, 541–554. http://doi.org/10.1007/s12571-014-0360-6

Anderson-Teixeira, K. J., Davis, S. C., Masters, M. D., and Delucia, E. H. 2009. Changes in soil organic carbon under biofuel crops. *GCB Bioenergy*, *1*1, 75–96. http://doi.org/10.1111/j.1757-1707.2008.01001.x

Anseeuw, W., Lay, J., Messerli, P., Giger, M., and Taylor, M. 2013. Creating a public tool to assess and promote transparency in global land deals: the experience of the Land Matrix. *Journal of Peasant Studies*, *40*3, 521–530. http://doi.org/10.1080/03066150.2013.803071

Antwi, E. K., and Wiegleb, G. 2008. Standards and Indicators for Monitoring Impact of Disturbance on Biodiversity in a Post-Mining Area Using GIS. In *Standards and Thresholds for Impact Assessment* pp. 277–290. Berlin, Heidelberg: Springer Berlin Heidelberg. http://doi.org/10.1007/978-3-540-31141-6_22

Antwi, E. K., Boakye-Danquah, J., Asabere, S. B., Takeuchi, K., and Wiegleb, G. 2014. Land cover transformation in two post-mining landscapes subjected to different ages of reclamation since dumping of spoils. *SpringerPlus*, *3*1, 702. http://doi.org/10.1186/2193-1801-3-702

Antwi, E. K., Owusu-Banahene, W., Boakye-Danquah, J., Mensah, R., Tetteh, J. D., Nagao, M., and Takeuchi, K. 2017. Sustainability assessment of mine-affected communities in Ghana: towards ecosystems and livelihood restoration. *Sustainability Science*, *12*5, 747–767. http://doi.org/10.1007/s11625-017-0474-9

Antwi, E., Bensah, E. C., Quansah, D. A., Arthur, R., and Ahiekpor, J. 2010. Ghana's biofuels policy : challenges and the way forward. *International Journal of Energy and Environment*, *1*5, 805–814.

Arevalo, J., Ochieng, R., Mola-Yudego, B., and Gritten, D. 2014. Understanding bioenergy conflicts: Case of a jatropha project in Kenya's Tana Delta. *Land Use Policy*, *41*, 138–148. http://doi.org/10.1016/j.landusepol.2014.05.002

Arndt, C., Benfica, R., and Thurlow, J. 2011. Gender Implications of Biofuels Expansion in Africa: The Case of Mozambique. *World Development*, *39*9, 1649–1662. http://doi.org/10.1016/j.worlddev.2011.02.012

Arndt, C., Benfica, R., Tarp, F., Thurlow, J., and Uaiene, R. 2010. Biofuels, poverty, and growth:

a computable general equilibrium analysis of Mozambique. *Environment and Development Economics*, *15*1, 81. http://doi.org/10.1017/S1355770X09990027

Arndt, C., Pauw, K., and Thurlow, J. 2012. Biofuels and economic development: A computable general equilibrium analysis for Tanzania. *Energy Economics*, *34*6, 1922–1930. http://doi.org/10.1016/j.eneco.2012.07.020

Arodudu, O., Helming, K., Wiggering, H., and Voinov, A. 2017. Towards a more holistic sustainability assessment framework for agro-bioenergy systems — A review. *Environmental Impact Assessment Review*, *62*, 61–75. http://doi.org/10.1016/j.eiar.2016.07.008

Asare, R. A., and Kwakye, Y. 2013. A Guide to Implementing REDD+ in Ghana: Criteria and modalities for developing a REDD+ project.

Asubonteng, K., Pfeffer, K., Ros-Tonen, M., Verbesselt, J., and Baud, I. 2018. Effects of Tree-crop Farming on Land-cover Transitions in a Mosaic Landscape in the Eastern Region of Ghana. *Environmental Management*. http://doi.org/10.1007/s00267-018-1060-3

Atkinson, A. B. 2003. Multidimensional Deprivation: Contrasting Social Welfare and Counting Approaches. *The Journal of Economic Inequality*, *1*1, 51–65. http://doi.org/10.1023/A:1023903525276

Attua, E. M., Awanyo, L., and Antwi, E. K. 2018. Effects of anthropogenic disturbance on tree population structure and diversity of a rain forest biosphere reserve in Ghana, West Africa. *African Journal of Ecology*, *56*1, 116–127. http://doi.org/10.1111/aje.12427

Awusabo-Asare, K., and Tanle, A. 2008. Eking a living: Women entrepreneurship and poverty reduction strategies: The case of palm kernel oil processing in the Central Region of Ghana. *Norsk Geografisk Tidsskrift - Norwegian Journal of Geography*, *62*3, 149–160. http://doi.org/10.1080/00291950802335525

Baccini, A., Laporte, N., Goetz, S. J., Sun, M., and Dong, H. 2008. A first map of tropical Africa's above-ground biomass derived from satellite imagery. *Environmental Research Letters*, *3*4, 45011. http://doi.org/10.1088/1748-9326/3/4/045011

Baumert, S. 2014. Life cycle assessment of carbon and energy balances in Jatropha production systems of Burkina Faso.

Baumert, S., Khamzina, A., and Vlek, P. L. G. 2016. Soil Organic Carbon Sequestration in *Jatropha curcas* Systems in Burkina Faso. *Land Degradation and Development*, *27*8, 1813–1819. http://doi.org/10.1002/ldr.2310

Becker, D. A., and Wittmeyer, H. 2013. Africa's Land Rush and the Embedded Neoliberal State: Foreign Agricultural Investment in Ethiopia and Mozambique. *Comparative Sociology*, *12*6, 753–784. http://doi.org/10.1163/15691330-12341284

Ben-Iwo, J., Manovic, V., and Longhurst, P. 2016. Biomass resources and biofuels potential for

the production of transportation fuels in Nigeria. *Renewable and Sustainable Energy Reviews*, *63*, 172–192. http://doi.org/10.1016/J.RSER.2016.05.050

Benjaminsen, T. A., Holden, S., and Lund, C. 2009. Formalisation of land rights: Some empirical evidence from Mali, Niger and South Africa. *Land Use Policy*, *26*1, 28–35. http://doi.org/10.1016/J.LANDUSEPOL.2008.07.003

Bergius, M. 2012. *Large Scale Agro Investments for Biofuel Production in Tanzania - Impact on Rural Households*. Adger.

Bernstein, H. 2010. *Class dynamics of agrarian change*. Fernwood; MA: Kumarian .

Biewen, M. 2002. Bootstrap inference for inequality, mobility and poverty measurement. *Journal of Econometrics*, *108*2, 317–342. http://doi.org/10.1016/S0304-40760100138-5

Black, E., Vidale, P. L., Verhoef, A., Cuadra, S. V., Osborne, T., and Van den Hoof, C. 2012. Cultivating C4 crops in a changing climate: sugarcane in Ghana. *Environmental Research Letters*, *7*4, 44027. http://doi.org/10.1088/1748-9326/7/4/044027

Boadi, S., Nsor, C. A., Yakubu, D. H., Acquah, E., and Antobre, O. O. 2017. Conventional and Indigenous Biodiversity Conservation Approach: A Comparative Study of Jachie Sacred Grove and Nkrabea Forest Reserve. *International Journal of Forestry Research*, *2017*, 1–8. http://doi.org/10.1155/2017/1721024

Boamah, F. 2011. The Relationship between Land Grabbing for Biofuels and Food Security, a Bane or Boon? The Food Security Implications of Jatropha Biodiesel Project in Northern Ghana. In *International Conference on Global Land Grabbing*. Brighton: Land Deals Politics Initiative .

Boamah, F. 2014a. How and why chiefs formalise land use in recent times: the politics of land dispossession through biofuels investments in Ghana. *Review of African Political Economy*, *41*141, 406–423. http://doi.org/10.1080/03056244.2014.901947

Boamah, F. 2014b. Imageries of the contested concepts "land grabbing" and "land transactions": Implications for biofuels investments in Ghana. *Geoforum*, *54*, 324–334. http://doi.org/10.1016/j.geoforum.2013.10.009

Boamah, F., and Overå, R. 2015. Rethinking Livelihood Impacts of Biofuel Land Deals in Ghana. *Development and Change*, *47*1, n/a-n/a. http://doi.org/10.1111/dech.12213

Borman, G. D., Von Maltitz, G. P., Tiwari, S., and Scholes, M. C. 2013. Modelling the economic returns to labour for Jatropha cultivation in southern Africa and India at different local fuel prices. *Biomass and Bioenergy*, *59*, 70–83. http://doi.org/10.1016/j.biombioe.2012.06.020

Borras, S. M., and Franco, J. C. 2013. Global Land Grabbing and Political Reactions "From Below." *Third World Quarterly*, *34*9, 1723–1747. http://doi.org/10.1080/01436597.2013.843845

Borras, S. M., McMichael, P., and Scoones, I. 2010. The politics of biofuels, land and agrarian change: editors' introduction. *The Journal of Peasant Studies*, *37*4, 575–592. http://doi.org/10.1080/03066150.2010.512448

Boucher, P., Smith, R., and Millar, K. 2014. Biofuels under the spotlight: The state of assessment and potential for integration. *Science and Public Policy*, *41*3, 283–293. http://doi.org/10.1093/scipol/scu028

Brew-Hammond, A. 2009. *Bioenergy for Accelerated Agro-Industrial Development in Ghana*. Accra.

Burel, F., Baudry, J., Butet, A., Clergeau, P., Delettre, Y., Le Coeur, D., Dubs, F., Morvan, N., Paillat, G., Petit, S., Thenail, C., Brunel, E., Lefeuvre, J.-C. 1998. Comparative biodiversity along a gradient of agricultural landscapes. *Acta Oecologica*, *19*(1), 47–60. http://doi.org/10.1016/S1146-609X(98)80007-6

Campion, B., and Acheampong, E. 2014. The Chieftaincy Institution in Ghana: Causers and Arbitrators of Conflicts in Industrial Jatropha Investments. *Sustainability*, *6*9, 6332–6350. http://doi.org/10.3390/su6096332

Carr, M. K. V. 2011. The water relations and irrigation requirements of oil palm elaeis guineensis: a review. *Experimental Agriculture*, *47*4, 629–652. http://doi.org/10.1017/S0014479711000494

Carreiras, J., Melo, J., and Vasconcelos, M. 2013. Estimating the Above-Ground Biomass in Miombo Savanna Woodlands Mozambique, East Africa Using L-Band Synthetic Aperture Radar Data. *Remote Sensing*, *5*4, 1524–1548. http://doi.org/10.3390/rs5041524

Cazzolla Gatti, R., Vaglio Laurin, G., and Valentini, R. 2017. Tree species diversity of three Ghanaian reserves. *iForest*, *10*, 362–368. http://doi.org/10.3832/ifor2056-010

Centre for Environment and Health Research and Training. 2009. *Final Environmental Impact Assessment: proposed jatropha farm project: Lolito*. Accra.

Centre for Environment and Health Research and Training. 2010a. *Final Environmental Impact Assessment: proposed jatropha farm project: Kobre*. Accra.

Centre for Environment and Health Research and Training. 2010b. *Final Environmental Impact Assessment: proposed jatropha farm project: Kpachaa*. Accra.

Chum, H., Faaij, A., Moreira, J., Berndes, G., Dhamija, P., Dong, H., Gabrielle, B., Goss Eng, A., Lucht, W., Mapako, M., Masera Cerutti, O., McIntyre, T., Minowa, T., Pingoud, K., 2011. Bioenergy. In: Edenhofer, O., Pichs-Madruga, R., Sokona, Y., Seyboth, K., Matschoss, P., Kadner, S., Zwickel, T., Eickemeier, P., Hansen, G., Schlömer, S., von Stechow, C. (Eds.), IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

Cleveland, C. J., Hall, C. A. S., and Herendeen, R. A. 2006. Energy Returns on Ethanol Production. *Science*, *312*5781, 1746–1748. http://doi.org/10.1126/science.312.5781.1746

Coates, J., Swindale, A., and Bilinsky, P. 2007. *Household Food Insecurity Access Scale HFIAS for Measurement of Food Access: Indicator Guide: Version 3*. Washington, D.C.

Collier, P., and Dercon, S. 2014. African Agriculture in 50 Years: Smallholders in a Rapidly Changing World? *World Development*, *63*, 92–101. http://doi.org/10.1016/j.worlddev.2013.10.001

Cotula, L. 2012. The international political economy of the global land rush: A critical appraisal of trends, scale, geography and drivers. *Journal of Peasant Studies*, *39*3–4, 649–680. http://doi.org/10.1080/03066150.2012.674940

Cotula, L. 2013. The New Enclosures? Polanyi, international investment law and the global land rush. *Third World Quarterly*, *34*9, 1605–1629. http://doi.org/10.1080/01436597.2013.843847

de Man, R., and German, L. 2017. Certifying the sustainability of biofuels: Promise and reality. *Energy Policy*. http://doi.org/10.1016/j.enpol.2017.05.047

De Schutter, O. 2011. How not to think of land-grabbing: three critiques of large-scale investments in farmland. *Journal of Peasant Studies*, *38*2, 249–279. http://doi.org/10.1080/03066150.2011.559008

Degefa, S., and Saito, O. 2017. Assessing the Impacts of Large-Scale Agro-Industrial Sugarcane Production on Biodiversity: A Case Study of Wonji Shoa Sugar Estate, Ethiopia. *Agriculture*, *7*12, 99. http://doi.org/10.3390/agriculture7120099

Degerickx, J., Almeida, J., Moonen, P. C. J., Vervoort, L., Muys, B., and Achten, W. M. J. 2016. Impact of land-use change to Jatropha bioenergy plantations on biomass and soil carbon stocks: a field study in Mali. *GCB Bioenergy*, *8*2, 443–455. http://doi.org/10.1111/gcbb.12288

Deikumah, J. P., Kwafo, R., and Konadu, V. A. 2017. Land use types influenced avian assemblage structure in a forest-agriculture landscape in Ghana. *Ecology and Evolution*, *7*21, 8685–8697. http://doi.org/10.1002/ece3.3355

Dell'Angelo, J., D'Odorico, P., Rulli, M. C., and Marchand, P. 2017. The Tragedy of the Grabbed Commons: Coercion and Dispossession in the Global Land Rush. *World Development*, *92*, 1–12. http://doi.org/10.1016/J.WORLDDEV.2016.11.005

Díaz, S., Demissew, S., Carabias, J., Joly, C., Lonsdale, M., Ash, N., Larigauderie, A., Adhikari, J.R., Arico, S., Báldi, A., Bartuska, A., Baste, I.A., Bilgin, A., Brondizio, E., Chan, K.M., Figueroa, V.E., Duraiappah, A., Fischer, M., Hill, R., Koetz, T., Leadley, P., Lyver, P., Mace, G.M., Martin-Lopez, B., Okumura, M., Pacheco, D., Pascual, U., Pérez, E.S., Reyers, B., Roth, E., Saito, O., Scholes, R.J., Sharma, N., Tallis, H., Thaman, R., Watson, R., Yahara, T., Hamid, Z.A., Akosim, C., Al-Hafedh, Y., Allahverdiyev, R., Amankwah, E.,

Asah, S.T., Asfaw, Z., Bartus, G., Brooks, L.A., Caillaux, J., Dalle, G., Darnaedi, D., Driver, A., Erpul, G., Escobar-Eyzaguirre, P., Failler, P., Fouda, A.M.M., Fu, B., Gundimeda, H., Hashimoto, S., Homer, F., Lavorel, S., Lichtenstein, G., Mala, W.A., Mandivenyi, W., Matczak, P., Mbizvo, C., Mehrdadi, M., Metzger, J.P., Mikissa, J.B., Moller, H., Mooney, H.A., Mumby, P., Nagendra, H., Nesshover, C., Oteng-Yeboah, A.A., Pataki, G., Roué, M., Rubis, J., Schultz, M., Smith, P., Sumaila, R., Takeuchi, K., Thomas, S., Verma, M., Yeo-Chang, Y., and Zlatanova, D. 2015. The IPBES Conceptual Framework — connecting nature and people. *Current Opinion in Environmental Sustainability*, *14*, 1–16. http://doi.org/10.1016/j.cosust.2014.11.002

Diop, D., Blanco, M., Flammini, A., Schlaifer, M., Kropiwnicka, M.A., and Markhof, M.M. 2013. Assessing the impact of biofuels production on developing countries from the point of view of policy coherence for development. European Commission, AETS Consortium, Belgium.

Disney, R. 1976. Some Measures of Rural Income Distribution in Ethiopia. *Development and Change*, *7*1, 35–44. http://doi.org/10.1111/j.1467-7660.1976.tb00698.x

Don, A., Schumacher, J., and Freibauer, A. 2011. Impact of tropical land-use change on soil organic carbon stocks - a meta-analysis. *Global Change Biology*, *17*4, 1658–1670. http://doi.org/10.1111/j.1365-2486.2010.02336.x

Dubb, A. 2016. The Rise and Decline of Small-Scale Sugarcane Production in South Africa: A Historical Perspective. *Journal of Agrarian Change*, *16*4, 518–542. http://doi.org/10.1111/joac.12107

Duku, M. H., Gu, S., and Hagan, E. Ben. 2011. A comprehensive review of biomass resources and biofuels potential in Ghana. *Renewable and Sustainable Energy Reviews*, *15*1, 404–415. http://doi.org/10.1016/j.rser.2010.09.033

Duvail, S., Médard, C., Hamerlynck, O., and Nyingi, D. W. 2012. Land and Water Grabbing in an East African Coastal Wetland: The Case of the Tana Delta. *Water Alternatives*, *5*2, 322–343.

Ebrahim, M. K., Zingsheim, O., EL-Shourbagy, M. N., Moore, P. H., Komor, E., and El-shourbagy, M. N. 1998. Growth and Sugar Storage in Sugarcane Grown at Temperatures Below and Above Optimum. *Journal of Plant Physiology*, *153*, 593–602. http://doi.org/10.1016/S0176-16179880209-5

ECOWAS. 2013. *Economic Community of West African States ECOWAS Bioenergy Strategy Framework*. Abuja.

Edelman, M. 2013. Messy hectares: questions about the epistemology of land grabbing data. *Journal of Peasant Studies*, *40*3, 485–501. http://doi.org/10.1080/03066150.2013.801340

Edrisi, S.A., Dubey, R.K., Tripathi, V., Bakshi, M., Srivastava, P., Jamil, S., Singh, H.B., Singh, N., Abhilash, P.C. 2015. Jatropha curcas L.: A crucified plant waiting for resurgence. *Renewable and Sustainable Energy Reviews*, *41*, 855–862.

http://doi.org/10.1016/j.rser.2014.08.082

Ellis, K., Singh, R., Quartey, P., and Agyare-Boakye, E. 2010. *Assessing the Economic Impact of Competition: Findings from Ghana*. London.

Energia, 2009. *Biofuels for sustainable rural development and empowerment of women: case studies from Africa and Asia*. Leusden: Energia

Energy Commission. 2006. *Strategic National Energy Plan 2006 – 2020*. Accra.

Energy Commission. 2010a. *Bioenergy Policy of Ghana*. Accra.

Energy Commission. 2010b. *National Energy Policy*. Accra.

Energy Commission. 2011. *Renewable Energy Act*. Accra.

Energy Commission. 2012. *Licence manual for service providers in the renewable energy industry*. Accra.

Eshton, B., Katima, J. H. Y., and Kituyi, E. 2013. Greenhouse gas emissions and energy balances of jatropha biodiesel as an alternative fuel in Tanzania. *Biomass and Bioenergy*, *58*, 95–103. http://doi.org/10.1016/J.BIOMBIOE.2013.08.020

European Commission. 2009. Directive 2009/28/EC Promotion of the use of energy from renewable sources. *Official Journal of the European Union*, *L140*, 16–62.

European Environment Agency. 2006) Land accounts for Europe 1990–2000. Copenhagen: European Environment Agency.

Favretto, N., Stringer, L. C., and Dougill, A. J. 2014. Unpacking livelihood challenges and opportunities in energy crop cultivation: perspectives on *Jatropha curcas* projects in Mali. *The Geographical Journal*, *180*4, 365–376. http://doi.org/10.1111/geoj.12053

Filip, O., Janda, K., Kristoufek, L., and Zilbermam, D. 2017. Food versus fuel: An updated and expanded evidence. *Energy Economics*. http://doi.org/10.1016/j.eneco.2017.10.033

Foga, S., Scaramuzza, P.L., Guo, S., Zhu, Z., Dilley, R.D., Beckmann, T., Schmidt, G.L., Dwyer, J.L., Hughes, M.J. and Laue, B. 2017. Cloud detection algorithm comparison and validation for operational Landsat data products. Remote Sensing of Environment, 194, 379-390.

Francois, M., Kofi, A., Saviour, A. W., and Harvim, P. 2015. Time Series and Factor Analysis of Sugar Cane Production: Case Study at Tosukpo, Volta Region, Ghana. *International Journal of Innovative Research and Development*, *4*4, 367–379.

Friese, S. 2014. *Qualitative data analysis with ATLAS.ti* Second. New York: Sage Publications.

Gasparatos, A. 2010. Embedded value systems in sustainability assessment tools and their implications. *Journal of Environmental Management*, *91*8, 1613–1622.

http://doi.org/10.1016/J.JENVMAN.2010.03.014

Gasparatos, A., Stromberg, P., and Takeuchi, K. 2011. Biofuels, ecosystem services and human wellbeing: Putting biofuels in the ecosystem services narrative. *Agriculture, Ecosystems and Environment*, *142*3, 111–128. http://doi.org/10.1016/j.agee.2011.04.020

Gasparatos, A., and Scolobig, A. 2012. Choosing the most appropriate sustainability assessment tool. *Ecological Economics*. http://doi.org/10.1016/j.ecolecon.2012.05.005

Gasparatos, A., Lee, L., Maltitz, G. P. von, Mathai, M. V., Oliveira, J. A. P. de, Johnson, F. X., and Willis, K. J. 2013. Catalysing biofuel sustainability - international and national policy interventions. *Environmental Policy and Law*, *43*4/5, 216–221.

Gasparatos, A., Lehtonen, M., and Stromberg, P. 2013. *Do we need a unified appraisal framework to synthesize biofuel impacts? Biomass and Bioenergy* Vol. 50.

Gasparatos, A., von Maltitz, G. P., Johnson, F. X., Lee, L., Mathai, M., Puppim de Oliveira, J. A., and Willis, K. J. 2015. Biofuels in sub-Sahara Africa: Drivers, impacts and priority policy areas. *Renewable and Sustainable Energy Reviews*, *45*, 879–901.

Gasparatos, A., Romeu-Dalmau, C., von Maltitz, G. P., Johnson, F. X., Shackleton, C., Jarzebski, M. P., Jumbe, C., Ochieng, C., Mudombi, S., Nyambane, A., Willis, K. J. 2018. Mechanisms and indicators for assessing the impact of biofuel feedstock production on ecosystem services. *Biomass and Bioenergy*. http://doi.org/10.1016/J.BIOMBIOE.2018.01.024

German, L., Schoneveld, G., and Gumbo, D. 2011. The local social and environmental impacts of smallholder-based biofuel investments in Zambia. *Ecology and Society*, *16*4. http://doi.org/10.5751/ES-04280-160412

German, L., Schoneveld, G., and Mwangi, E. 2013. Contemporary Processes of Large-Scale Land Acquisition in Sub-Saharan Africa: Legal Deficiency or Elite Capture of the Rule of Law? *World Development*, *48*, 1–18. http://doi.org/10.1016/j.worlddev.2013.03.006

Ghana Statistical Service. 2015. *Ghana poverty mapping report*. Accra.

Goetz, A., German, L., Hunsberger, C., and Schmidt, O. 2017. Do no harm? Risk perceptions in national bioenergy policies and actual mitigation performance. *Energy Policy*. http://doi.org/10.1016/j.enpol.2017.03.067

Golow, A. A., Agyemang, O., and Ackah, M. 2010. Soil fertility analysis in two oil palm plantation towns in Assin North District of the Central Region of Ghana. *Australian Journal of Basic and Applied Sciences*, *4*7, 1650–1655.

Hackman, K. O., and Gong, P. 2017. Biodiversity estimation of the western region of Ghana using arthropod mean morphospecies abundance. *Biodiversity and Conservation*, *26*9, 2083–2097. http://doi.org/10.1007/s10531-017-1346-4

Hall, R. 2011. Land grabbing in Southern Africa: the many faces of the investor rush. *Review of African Political Economy*, *38*128, 193–214. http://doi.org/10.1080/03056244.2011.582753

Handoh, I. C., and Hidaka, T. 2010. On the timescales of sustainability and futurability. *Futures*, *42*7, 743–748. http://doi.org/10.1016/J.FUTURES.2010.04.023

Hansen, M., Conteh, M., Shakya, M., and Loewenstein, W. 2016. *Determining Minimum Compensation for Lost Farmland: A Theory-Based Impact Evaluation of a Land Grab in Sierra Leone* IEE Working Paper No. 211. Bochum.

Hashim, N. 2014. How Knowledge, Policy Planning, and Implementation Succeed or Fail: The Jatropha Projects in Tanzania. *Journal of African Business*, *15*3, 169–183. http://doi.org/10.1080/15228916.2014.956640

Haughton, J., and Khandker, S. R. 2009. *Handbook on poverty and inequality* 1st ed.. Washington, DC: World Bank.

Hausermann, H., Ferring, D., Atosona, B., Mentz, G., Amankwah, R., Chang, A., Hartfield, K., Effah, E., Asuamah, G.Y., Mansell, C., Sastri, N. 2018. Land-grabbing, land-use transformation and social differentiation: Deconstructing "small-scale" in Ghana's recent gold rush. *World Development*, *108*, 103–114. http://doi.org/10.1016/j.worlddev.2018.03.014

Hayashi, T., van Ierland, E. C., and Zhu, X. 2014. A holistic sustainability assessment tool for bioenergy using the Global Bioenergy Partnership GBEP sustainability indicators. *Biomass and Bioenergy*, *66*, 70–80. http://doi.org/10.1016/j.biombioe.2014.01.040

Henry, M., Picard, N., Trotta, C., Manlay, R., Valentini, R., Bernoux, M., and Saint-André, L. 2011. Estimating tree biomass of sub-Saharan African forests: a review of available allometric equations. *Silva Fennica*, *45*3B. http://doi.org/10.14214/sf.38

Hess, T. M., Sumberg, J., Biggs, T., Georgescu, M., Haro-Monteagudo, D., Jewitt, G., Ozdogan, M., Marshall, M., Thenkabail, P., Daccache, A., Marin, F., Knox, J. W. 2016. A sweet deal? Sugarcane, water and agricultural transformation in Sub-Saharan Africa. *Global Environmental Change*, *39*, 181–194. http://doi.org/10.1016/j.gloenvcha.2016.05.003

Hill, J., Nelson, E., Tilman, D., Polasky, S., and Tiffany, D. 2006. Environmental, economic, and energetic costs and benefits of biodiesel and ethanol biofuels. *Proceedings of the National Academy of Sciences*, *103*30, 11206–11210. http://doi.org/10.1073/pnas.0604600103

Hodbod, J., and Tomei, J. 2013. Demystifying the social impacts of biofuels at local levels: Where is the evidence? *Geography Compass*, *7*7, 478–488. http://doi.org/10.1111/gec3.12051

Huddleston, P., and Tonts, M. 2007. Agricultural Development, Contract Farming and Ghana's Oil Palm Industry. *Geography*. Geographical Association. http://doi.org/10.2307/40574339

Hultman, N. E., Sulle, E. B., Ramig, C. W., and Sykora-Bodie, S. 2012. Biofuels Investments in

Tanzania. *The Journal of Environment and Development*, *21*3, 339–361. http://doi.org/10.1177/1070496511435665

Hunsberger, C. 2010. The politics of *Jatropha* -based biofuels in Kenya: convergence and divergence among NGOs, donors, government officials and farmers. *The Journal of Peasant Studies*, *37*4, 939–962. http://doi.org/10.1080/03066150.2010.512465

Hunsberger, C., German, L., and Goetz, A. 2017. "Unbundling" the biofuel promise: Querying the ability of liquid biofuels to deliver on socio-economic policy expectations. *Energy Policy*. http://doi.org/10.1016/j.enpol.2017.04.017

Iddrisu, I., and Bhattacharyya, S. C. 2015. Ghana′s bioenergy policy: Is 20% biofuel integration achievable by 2030? *Renewable and Sustainable Energy Reviews*, *43*, 32–39. http://doi.org/10.1016/j.rser.2014.10.066

Iiyama, M., Newman, D., Munster, C., Nyabenge, M., Sileshi, G. W., Moraa, V., Onchieku, J., Mowo, J.G., Jamnadass, R. 2012. Productivity of Jatropha curcas under smallholder farm conditions in Kenya. *Agroforestry Systems*, *87*4, 729–746. http://doi.org/10.1007/s10457-012-9592-7

Immerzeel, D. J., Verweij, P. A., van der Hilst, F., and Faaij, A. P. C. 2014. Biodiversity impacts of bioenergy crop production: a state-of-the-art review. *GCB Bioenergy*, *6*3, 183–209. http://doi.org/10.1111/gcbb.12067

International Energy Agency. 2007. *IEA Energy Technology Essentials: Biofuel Production*. Paris.

International Energy Agency. 2014. *Africa Energy Outlook - A Focus on Energy Prospects in Sub Saharan Africa - ICA*. Paris.

IPCC. 2006. *IPCC Guidelines for national greenhouse gas inventories*. Geneva.

Jin, E., and Sutherland, J. W. 2016. A Proposed Integrated Sustainability Model for a Bioenergy System. *Procedia CIRP*, *48*, 358–363. http://doi.org/10.1016/j.procir.2016.03.159

Kant, P., and Wu, S. 2011. The Extraordinary Collapse of Jatropha as a Global Biofuel. *Environmental Science and Technology*, *45*17, 7114–7115. http://doi.org/10.1021/es201943v

Karavina, C., Zivenge, E., Mandumbu, R., and Parwada, C. 2011. Jatropha curcas Production in Zimbabwe: Uses, Challenges and the Way Forward. Modern Applied Science, 52, 239–243. http://doi.org/10.5539/mas.v5n2p239

Kates, R. W. 2011. What kind of a science is sustainability science? *Proceedings of the National Academy of Sciences of the United States of America*, *108*49, 19449–50. http://doi.org/10.1073/pnas.1116097108

Kates, R.W., Clark, W.C., Corell, R., Hall, J.M., Jaeger, C.C., Lowe, I., McCarthy, J.J.,

Schellnhuber, H.J., Bolin, B., Dickson, N.M., Faucheux, S., Gallopin, G.C., Grübler, A., Huntley, B., Jäger, J., Jodha, N.S., Kasperson, R.E., Mabogunje, A., Matson, P., Mooney, H., Moore, B., O'Riordan, T., Svedin, U. 2001. Sustainability Science. *Science*, *292*5517.

Kgathi, D. L., Mfundisi, K. B., Mmopelwa, G., and Mosepele, K. 2012. Potential impacts of biofuel development on food security in Botswana: A contribution to energy policy. *Energy Policy*, *43*, 70–79. http://doi.org/10.1016/j.enpol.2011.12.027

Khalid, H., Zin, Z. Z., and Anderson, J. M. 1999. Quantification of oil palm biomass and nutrient value in a mature plantation. II. Below-ground biomass. *Journal of Oil Palm Research*, *11*2, 63–71.

Khishtandar, S., Zandieh, M., and Dorri, B. 2016. A multi criteria decision making framework for sustainability assessment of bioenergy production technologies with hesitant fuzzy linguistic term sets: The case of Iran. *Renewable and Sustainable Energy Reviews*. http://doi.org/10.1016/j.rser.2016.11.212

Kho, L. K., and Jepsen, M. R. 2015. Carbon stock of oil palm plantations and tropical forests in Malaysia: A review. Singapore Journal of Tropical Geography, 362, 249–266. http://doi.org/10.1111/sjtg.12100

Kidido, J. ., Ayitey, J. ., Kuusaana, E. ., and Gavu, E. . 2015. Who is the rightful recipient of mining compensation for land use deprivation in Ghana? *Resources Policy*, *43*, 19–27. http://doi.org/10.1016/j.resourpol.2014.10.004

Kidido, J. K., and Kuusaana, E. D. 2014. Large-Scale Investment in Biofuel Feedstock Production and Emerging Land Issues in Ghana. *Journal of Social Science Studies*, *1*2, 163. http://doi.org/10.5296/jsss.v1i2.5114

Kuchler, M., and Linnér, B.-O. 2012a. Challenging the food vs. fuel dilemma: Genealogical analysis of the biofuel discourse pursued by international organizations. *Food Policy*, *37*, 581–588. http://doi.org/10.1016/j.foodpol.2012.06.005

Kuchler, M., and Linnér, B.-O. 2012b. Challenging the food vs. fuel dilemma: Genealogical analysis of the biofuel discourse pursued by international organizations. *Food Policy*, *37*5, 581–588. http://doi.org/10.1016/j.foodpol.2012.06.005

Kuntashula, E., van der Horst, D., and Vermeylen, S. 2014. A pro-poor biofuel? Household wealth and farmer participation in Jatropha curcas seed production and exchange in eastern Zambia. *Biomass and Bioenergy*, *63*, 187–197. http://doi.org/10.1016/j.biombioe.2014.01.051

Kuusaana, E. D., and Bukari, K. N. 2015. Land conflicts between smallholders and Fulani pastoralists in Ghana: Evidence from the Asante Akim North District AAND. *Journal of Rural Studies*, *42*, 52–62. http://doi.org/10.1016/j.jrurstud.2015.09.009

Kyerematen, R., Owusu, E. H., Acquah-Lamptey, D., Anderson, R. S., and Ntiamoa-Baidu, Y. 2014. Species Composition and Diversity of Insects of the Kogyae Strict Nature Reserve in

Ghana. *Open Journal of Ecology*, *4*17, 1061–1079. http://doi.org/10.4236/oje.2014.417087

Larbi, W. O., Antwi, A., and Olomolaiye, P. 2004. Compulsory land acquisition in Ghana—policy and praxis. *Land Use Policy*, *21*2, 115–127. http://doi.org/10.1016/j.landusepol.2003.09.004

Larson, D. F., Muraoka, R., and Otsuka, K. 2016. Why African rural development strategies must depend on small farms. *Global Food Security*, *10*, 39–51. http://doi.org/10.1016/j.gfs.2016.07.006

Liew, W. H., Hassim, M. H., and Ng, D. K. S. 2014. Review of evolution, technology and sustainability assessments of biofuel production. *Journal of Cleaner Production*, *71*, 11–29. http://doi.org/10.1016/J.JCLEPRO.2014.01.006

Locke, A., and Henley, G. 2013a. A review of the literature on biofuels and food security at a local level Assessing the state of the evidence. London: Overseas Development Institute.

Locke, A., and Henley, G. 2013b. *Scoping report on biofuels projects in five developing countries*. London.

Lu, D., Mausel, P., Brondízio, E., and Moran, E. 2004. Change detection techniques. *International Journal of Remote Sensing*, *25*12, 2365–2401. http://doi.org/10.1080/0143116031000139863

Lu, W., and Horlu, D. S. A. 2017. Economic well-being of rural farm households in Ghana: A perspective of inequality and polarisation. http://doi.org/10.1016/j.jrurstud.2017.08.013

Martin, M., Mwakaje, A. G., and Eklund, M. 2009. Biofuel development initiatives in Tanzania: development activities, scales of production and conditions for implementation and utilization. *Journal of Cleaner Production*, *17*, S69–S76. http://doi.org/10.1016/J.JCLEPRO.2009.05.002

Matenga, C. R. 2017. Outgrowers and Livelihoods: The Case of Magobbo Smallholder Block Farming in Mazabuka District in Zambia. *Journal of Southern African Studies*, *43*3, 551–566. http://doi.org/10.1080/03057070.2016.1211402

Maxwell, D., and Caldwell, R. 2008. *The Coping Strategies Index A tool for rapid measurement of household food security and the impact of food aid programs in humanitarian emergencies, Field Methods Manual* Second. Atlanta: Cooperative for Assistance and Relief Everywhere, Inc. CARE.

McPherson, J. M., Sammy, J., Sheppard, D. J., Mason, J. J., Brichieri-Colombi, T. A., and Moehrenschlager, A. 2016. Integrating traditional knowledge when it appears to conflict with conservation: lessons from the discovery and protection of sitatunga in Ghana. *Ecology and Society*, *21*1, art24. http://doi.org/10.5751/ES-08089-210124

Mellor, J. W., and Malik, S. J. 2017. The Impact of Growth in Small Commercial Farm Productivity on Rural Poverty Reduction. *World Development*, *91*, 1–10.

http://doi.org/10.1016/j.worlddev.2016.09.004

Messerli, P., Giger, M., Dwyer, M. B., Breu, T., and Eckert, S. 2014. The geography of large-scale land acquisitions: Analysing socio-ecological patterns of target contexts in the global South. Applied Geography, 53, 449–459. http://doi.org/10.1016/J.APGEOG.2014.07.005

Meyer, M. A., and Priess, J. A. 2014. Indicators of bioenergy-related certification schemes – An analysis of the quality and comprehensiveness for assessing local/regional environmental impacts. *Biomass and Bioenergy*, *65*, 151–169. http://doi.org/10.1016/J.BIOMBIOE.2014.03.041

Mhlanga, B. F. N., Ndlovu, L. S., and Senzanje, A. 2006. Impacts of irrigation return flows on the quality of the receiving waters: A case of sugarcane irrigated fields at the Royal Swaziland Sugar Corporation RSSC in the Mbuluzi River Basin Swaziland. *Physics and Chemistry of the Earth, Parts A/B/C*, *31*15–16, 804–813. http://doi.org/10.1016/J.PCE.2006.08.028

Michel-Dounias, I., Steer, L., Giry, E., Jannot, C., and Kalms, J.-M. 2015. Development of Oil Palm Plantations and Orange Groves in the Heart of the Cocoa Territory in Eastern Ghana. In *Economics and Ecology of Diversification* pp. 121–141. Dordrecht: Springer Netherlands. http://doi.org/10.1007/978-94-017-7294-5_5

Ministry of Energy and Minerals. 2010. *Guidelines For Sustainable Liquid Biofuels Development in Tanzania*. Dar es Salaam.

Ministry of Environment Science Technology and Innovation. 2014. *Invasive Alien Species Policy*. Accra .

Ministry of Food and Agriculture. 2011. *Master plan study of the Oil palm industry in Ghana*. Hampshire: MASDAR.

Ministry of Food and Agriculture. 2015. *Agriculture in Ghana: Facts and Figures*. Accra.

Ministry of Trade and Industry. 2016. *Ghana Sugar Policy: Intent and Development Process*. Accra.

Mireku, K. O., Kuusaana, E. D., and Kidido, J. K. 2016. Legal implications of allocation papers in land transactions in Ghana—A case study of the Kumasi traditional area. *Land Use Policy*, *50*, 148–155. http://doi.org/10.1016/j.landusepol.2015.09.015

Mitchell, D. 2011. *Biofuels in Africa : Opportunities, Prospects, and Challenges. Directions in Development; countries and regions*. Washington DC: The World Bank. http://doi.org/10.1596/978-0-8213-8516-6

Mohammed, A. M., Robinson, J. S., Midmore, D., and Verhoef, A. 2016. Carbon storage in Ghanaian cocoa ecosystems. *Carbon Balance and Management*, *11*1, 6. http://doi.org/10.1186/s13021-016-0045-x

Mokany, K., Raison, R. J., and Prokushkin, A. S. 2006. Critical analysis of root : shoot ratios in terrestrial biomes. *Global Change Biology*, *12*1, 84–96. http://doi.org/10.1111/j.1365-2486.2005.001043.x

Moreno-Peñaranda, R., Gasparatos, A., Stromberg, P., Suwa, A., Pandyaswargo, A. H., and Puppim de Oliveira, J. A. 2015. Sustainable production and consumption of palm oil in Indonesia: What can stakeholder perceptions offer to the debate? *Sustainable Production and Consumption*, *4*, 16–35. http://doi.org/10.1016/j.spc.2015.10.002

Morris, S. S., Carletto, C., Hoddinott, J., and Christiaensen, L. J. 2000. Validity of rapid estimates of household wealth and income for health surveys in rural Africa. *Journal of Epidemiology and Community Health*, *54*5, 381–7. http://doi.org/10.1136/JECH.54.5.381

Mudombi, S., Von Maltitz, G. P., Gasparatos, A., Romeu-Dalmau, C., Johnson, F. X., Jumbe, C., Ochieng, C., Luhanga, D., Lopes, P., Balde, B.S., Willis, K. J. 2016. Multi-dimensional poverty effects around operational biofuel projects in Malawi, Mozambique and Swaziland. *Biomass and Bioenergy*. http://doi.org/10.1016/j.biombioe.2016.09.003

Mueller, S. A., Anderson, J. E., and Wallington, T. J. 2011. Impact of biofuel production and other supply and demand factors on food price increases in 2008. *Biomass and Bioenergy*, *35*5, 1623–1632. http://doi.org/10.1016/j.biombioe.2011.01.030

Mulwa, R. K., Böhning-Gaese, K., and Schleuning, M. 2012. High Bird Species Diversity in Structurally Heterogeneous Farmland in Western Kenya. *Biotropica*, *44*6, 801–809. http://doi.org/10.1111/j.1744-7429.2012.00877.x

Mwangi, D., Kasina, M., Nderitu, J., Hagen, M., Gikungu, M., and Kraemer, M. 2012. Diversity and abundance of native bees foraging on hedgerow plants in the Kakamega farmlands, western Kenya. *Journal of Apicultural Research*, *51*4, 298–305. http://doi.org/10.3896/IBRA.1.51.4.02

Myllyviita, T., Leskinen, P., Lähtinen, K., Pasanen, K., Sironen, S., Kähkönen, T., and Sikanen, L. 2013. Sustainability assessment of wood-based bioenergy – A methodological framework and a case-study. *Biomass and Bioenergy*, *59*, 293–299. http://doi.org/10.1016/j.biombioe.2013.07.010

Naik, S. N., Goud, V. V., Rout, P. K., and Dalai, A. K. 2010. Production of first and second generation biofuels: A comprehensive review. *Renewable and Sustainable Energy Reviews*, *14*2, 578–597. http://doi.org/10.1016/J.RSER.2009.10.003

Nardo, M., Saisana, M., Saltelli, M., Tarantola, S., Hoffman, A., and Giovannini, E. 2008. *Handbook on Constructing Composite Indicators: Methodology and User Guide*. Paris: Organisation for Economic Co-operation and Development.

Nchanji, Y. K., Nkongho, R. N., Mala, W. A., and Levang, P. 2016. Efficacy of oil palm intercropping by smallholders. Case study in South-West Cameroon. *Agroforestry Systems*, *90*3, 509–519. http://doi.org/10.1007/s10457-015-9873-z

Ndong, R., Montrejaud-Vignoles, M., Saint Girons, O., Gabrielle, B., Pirot, R., Domergue, M., And Sablayrolles, C. 2009. Life cycle assessment of biofuels from Jatropha curcas in West Africa: a field study. *GCB Bioenergy*, *1*3, 197–210. http://doi.org/10.1111/j.1757-1707.2009.01014.x

Neimark, B. D. 2016. Biofuel imaginaries: The emerging politics surrounding "inclusive" private sector development in Madagascar. *Journal of Rural Studies*, *45*, 146–156. http://doi.org/10.1016/j.jrurstud.2016.03.012

Ness, B., Urbel-Piirsalu, E., Anderberg, S., and Olsson, L. 2007. Categorising tools for sustainability assessment. *Ecological Economics*, *60*3, 498–508. http://doi.org/10.1016/J.ECOLECON.2006.07.023

Nhiwatiwa, T., Dalu, T., and Brendonck, L. 2017. Impact of irrigation based sugarcane cultivation on the Chiredzi and Runde Rivers quality, Zimbabwe. *Science of The Total Environment*, *587–588*, 316–325. http://doi.org/10.1016/j.scitotenv.2017.02.155

Nussbaumer, P., Bazilian, M., and Modi, V. 2012. Measuring energy poverty: Focusing on what matters. *Renewable and Sustainable Energy Reviews*, *16*, 231–243. http://doi.org/10.1016/j.rser.2011.07.150

Nyari, B. 2008. *Biofuel land grabbing in Northern Ghana*. Thika.

Nygaard, I., and Bolwig, S. 2017. *Evolution of the jatropha biofuel niche in Ghana* UNEP DTU Partnership Working Paper Series No. 1. Lyngby.

Obeng-Odoom, F. 2015. Understanding Land Grabs in Africa: Insights from Marxist and Georgist Political Economics. *The Review of Black Political Economy*, *42*4, 337–354. http://doi.org/10.1007/s12114-015-9209-2

Oberlack, C., Tejada, L., Messerli, P., Rist, S., and Giger, M. 2016. Sustainable livelihoods in the global land rush? Archetypes of livelihood vulnerability and sustainability potentials. *Global Environmental Change*, *41*, 153–171. http://doi.org/10.1016/j.gloenvcha.2016.10.001

OECD. 2013. *OECD Guidelines on Measuring Subjective Well-being*. OECD Publishing. http://doi.org/10.1787/9789264191655-en

Ofosu-Budu, K., and Sarpong, D. B. 2013. Oil palm industry growth in Africa: A value chain and smallholders' study for Ghana*. In A. Elbehri Ed., *Rebuilding West Africa's Food Potential*. Rome : FAO/IFAD.

Ogundari, I. O., Momodu, A. S., Famurewa, A. J., Akarakiri, J. B., and Siyanbola, W. O. 2012. Analysis of sustainable cassava biofuel production in Nigeria. *Energy and Environment*. Sage Publications, Ltd. http://doi.org/10.2307/43735122

Ordway, E. M., Naylor, R. L., Nkongho, R. N., and Lambin, E. F. 2017. Oil palm expansion in Cameroon: Insights into sustainability opportunities and challenges in Africa. *Global*

Environmental Change, *47*, 190–200. http://doi.org/10.1016/J.GLOENVCHA.2017.10.009

Osei-Amponsah, C., Visser, L., Adjei-Nsiah, S., Struik, P. C., Sakyi-Dawson, O., and Stomph, T. J. 2012. Processing practices of small-scale palm oil producers in the Kwaebibirem District, Ghana: A diagnostic study. *NJAS - Wageningen Journal of Life Sciences*, *60–63*, 49–56. http://doi.org/10.1016/J.NJAS.2012.06.006

Ostrom, E. 2009. A General Framework for Analyzing Sustainability of Social-Ecological Systems. *Science*, *325*5939.

Pedersen, R. H. 2016. Access to land reconsidered: The land grab, polycentric governance and Tanzania's new wave land reform. *Geoforum*. http://doi.org/10.1016/j.geoforum.2015.12.010

Pollesch, N. L., and Dale, V. H. 2016. Normalization in sustainability assessment: Methods and implications. *Ecological Economics*, *130*, 195–208. http://doi.org/10.1016/J.ECOLECON.2016.06.018

Pontius, R. G., Shusas, E., and McEachern, M. 2004. Detecting important categorical land changes while accounting for persistence. *Agriculture, Ecosystems and Environment*, *101*2–3, 251–268. http://doi.org/10.1016/J.AGEE.2003.09.008

Pradhan, A., and Mbohwa, C. 2014. Development of biofuels in South Africa: Challenges and opportunities. *Renewable and Sustainable Energy Reviews*, *39*, 1089–1100. http://doi.org/10.1016/j.rser.2014.07.131

Pradhan, S., and Ruysenaar, S. 2014. Burning Desires: Untangling and Interpreting "Pro-Poor" Biofuel Policy Processes in India and South Africa. *Environment and Planning A*, *46*2, 299–317. http://doi.org/10.1068/a45482

Prakash, A. R., Singh, S., Prakash, C. R., Ghosh, A., and Agarwal, P. K. 2016. Development of Jatropha hybrids with enhanced growth, yield and oil attributes suitable for semi-arid wastelands. *Agroforestry Systems*, *90*3, 541–553. http://doi.org/10.1007/s10457-015-9875-x

REN21, 2018. Renewables 2018 Global Status Report. Paris.

Ribot, J. C. 1996. Participation Without Representation: Chiefs, Councils and Forestry Law in the West African Sahel. *Cultural Survival Quarterly*, 1–10.

Rimppi, H., Uusitalo, V., Väisänen, S., and Soukka, R. 2016. Sustainability criteria and indicators of bioenergy systems from steering, research and Finnish bioenergy business operators' perspectives. *Ecological Indicators*, *66*, 357–368. http://doi.org/10.1016/j.ecolind.2016.02.005

Romeu-Dalmau, C., Gasparatos, A., von Maltitz, G., Graham, A., Almagro-Garcia, J., Wilebore, B., and Willis, K. J. 2016. Impacts of land use change due to biofuel crops on climate regulation services: Five case studies in Malawi, Mozambique and Swaziland. *Biomass and*

Bioenergy. http://doi.org/10.1016/j.biombioe.2016.05.011

Romijn, H., Heijnen, S., Colthoff, J., de Jong, B., and van Eijck, J. 2014. Economic and Social Sustainability Performance of Jatropha Projects: Results from Field Surveys in Mozambique, Tanzania and Mali. *Sustainability*, *6*9, 6203–6235. http://doi.org/10.3390/su6096203

Ryan, C. M., Williams, M., and Grace, J. 2011. Above- and Belowground Carbon Stocks in a Miombo Woodland Landscape of Mozambique. *Biotropica*, *43*4, 423–432. http://doi.org/10.1111/j.1744-7429.2010.00713.x

Sastre, C. M., Carrasco, J., Barro, R., González-Arechavala, Y., Maletta, E., Santos, A. M., and Ciria, P. 2016. Improving bioenergy sustainability evaluations by using soil nitrogen balance coupled with life cycle assessment: A case study for electricity generated from rye biomass. *Applied Energy*, *179*, 847–863. http://doi.org/10.1016/j.apenergy.2016.07.022

Savilaakso, S., Garcia, C., Garcia-Ulloa, J., Ghazoul, J., Groom, M., Guariguata, M. R., Laumonier, Y., Nasi, R., Petrokofsky, G., Snaddon, J., Zrust, M. 2014. Systematic review of effects on biodiversity from oil palm production. *Environmental Evidence*, *3*4, 1–20. http://doi.org/10.1186/2047-2382-3-4

Schoneveld, G. 2014. The geographic and sectoral patterns of large-scale farmland investments in sub-Saharan Africa. *Food Policy*, *48*, 34–50. http://doi.org/10.1016/j.foodpol.2014.03.007

Schoneveld, G. 2017. Host country governance and the African land rush: 7 reasons why large-scale farmland investments fail to contribute to sustainable development. *Geoforum*, *83*, 119–132. http://doi.org/10.1016/J.GEOFORUM.2016.12.007

Schoneveld, G., and German, L. 2013. Translating Legal Rights into Tenure Security: Lessons from the New Commercial Pressures on Land in Ghana. *The Journal of Development Studies*, *50*2, 187–203. http://doi.org/10.1080/00220388.2013.858129

Schoneveld, G., and German, L. 2014. Translating Legal Rights into Tenure Security: Lessons from the New Commercial Pressures on Land in Ghana. *The Journal of Development Studies*, *50*2, 187–203. http://doi.org/10.1080/00220388.2013.858129

Schoneveld, G., German, L. a, and Nutakor, E. 2011. Land-based Investments for Rural Development? A Grounded Analysis of the Local Impacts of Biofuel Feedstock Plantations in Ghana. *Ecology and Society*, *16*4, 10-. http://doi.org/10.5751/es-04424-160410

Schut, M., Cunha Soares, N., van de Ven, G., and Slingerland, M. 2014. Multi-actor governance of sustainable biofuels in developing countries: The case of Mozambique. *Energy Policy*, *65*, 631–643. http://doi.org/10.1016/J.ENPOL.2013.09.007

Schut, M., Slingerland, M., and Locke, A. 2010. Biofuel developments in Mozambique. Update and analysis of policy, potential and reality. *Energy Policy*, *38*9, 5151–5165. http://doi.org/10.1016/J.ENPOL.2010.04.048

Sekoai, P., and Yoro, K. 2016. Biofuel Development Initiatives in Sub-Saharan Africa: Opportunities and Challenges. Climate, 42, 33. http://doi.org/10.3390/cli4020033

Shackleton, C. M., and Scholes, R. J. 2011. Above ground woody community attributes, biomass and carbon stocks along a rainfall gradient in the savannas of the central lowveld, South Africa. *South African Journal of Botany*, *77*1, 184–192. http://doi.org/10.1016/J.SAJB.2010.07.014

Shannon, C. E. 1948. A Mathematical Theory of Communication. *Bell System Technical Journal*, *27*3, 379–423. http://doi.org/10.1002/j.1538-7305.1948.tb01338.x

Shortall, O. K. 2013. "Marginal land" for energy crops: Exploring definitions and embedded assumptions. *Energy Policy*, *62*, 19–27. http://doi.org/10.1016/j.enpol.2013.07.048

Sulle, E. 2017. Social Differentiation and the Politics of Land: Sugar Cane Outgrowing in Kilombero, Tanzania. *Journal of Southern African Studies*, *43*3, 517–533. http://doi.org/10.1080/03057070.2016.1215171

Suwelack, K., and Wüst, D. 2015. An approach to unify the appraisal framework for biomass conversion systems. *Biomass and Bioenergy*, *83*, 354–365. http://doi.org/10.1016/J.BIOMBIOE.2015.10.012

Talukder, B., W. Hipel, K., and W. vanLoon, G. 2017. Developing Composite Indicators for Agricultural Sustainability Assessment: Effect of Normalization and Aggregation Techniques. *Resources*, *6*4, 66. http://doi.org/10.3390/resources6040066

Tenenbaum, D. J. 2008. Food vs. fuel: diversion of crops could cause more hunger. *Environmental Health Perspectives*, *116*6, A254-7.

Thompson, G. D. 1978. The production of biomass by sugarcane. *Proceedings of the South African Sugar Technologists' Association*, 52 1978: 180-187.

Thresh, J. M., and Owusu, G. K. 1986. The control of cocoa swollen shoot disease in Ghana: an evaluation of eradication procedures. *Crop Protection*, *5*1, 41–52. http://doi.org/10.1016/0261-21948690037-2

Timko, J., Amsalu, A., Acheampong, E., and Teferi, M. 2014. Local Perceptions about the Effects of Jatropha Jatropha curcas and Castor Ricinus communis Plantations on Households in Ghana and Ethiopia. *Sustainability*, *6*10, 7224–7241. http://doi.org/10.3390/su6107224

Tom-Dery, D., Hinneh, P., and Asante, W. J. 2013. African Journal of Agricultural Research Biodiversity in Kenikeni Forest Reserve of Northern Ghana, *8*46, 5896–5904. http://doi.org/10.5897/AJAR12.1886

Tomei, J., and Helliwell, R. 2015. Food versus fuel? Going beyond biofuels. *Land Use Policy*. http://doi.org/10.1016/j.landusepol.2015.11.015

Traore, P.C.S., Lamien, N., Ayantunde, A.A., Bayala, J., Kalinganire, A., Binam, J.N., Carey, E., Emechebe, A., Namara, R., Tondoh, J.E., Vodouhe, R. 2014. Sampling the vulnerability reduction-sustainable intensification continuum: a West African paradigm for selection of Dryland Systems sites. *Global Climate Change and Its Impact on Food andamp; Energy Security in the Drylands, Proceedings of the Eleventh International Dryland Development Conference, 18-21 March 2013, Beijing, China*, 186–204.

Tsikata, D., and Yaro, J. A. 2013. When a Good Business Model is Not Enough: Land Transactions and Gendered Livelihood Prospects in Rural Ghana. *Feminist Economics*, *20*1, 202–226. http://doi.org/10.1080/13545701.2013.866261

UNDESA. 2007. *Small-Scale Production and Use of Liquid Biofuels in Sub-Saharan Africa: Perspectives for Sustainable Development* DESA/DSD No. 2. New York.

Valdez-Vazquez, I., del Rosario Sánchez Gastelum, C., and Escalante, A. E. 2017. Proposal for a sustainability evaluation framework for bioenergy production systems using the MESMIS methodology. *Renewable and Sustainable Energy Reviews*, *68*, 360–369. http://doi.org/10.1016/j.rser.2016.09.136

Vallis, I., Parton, W. J., Keating Av, B. A., and Wood ', A. W. 1996. Simulation of the effects of trash and N fertilizer management on soil organic matter levels and yields of sugarcane. Soiland TUbrge Research Soil and Tillage Research, 38, 115–132.

van Eijck, J., Romijn, H., Balkema, A., and Faaij, A. 2014. Global experience with jatropha cultivation for bioenergy: An assessment of socio-economic and environmental aspects. *Renewable and Sustainable Energy Reviews*, *32*, 869–889. http://doi.org/10.1016/J.RSER.2014.01.028

Van Eijck, J., Romijn, H., Smeets, E., Bailis, R., Rooijakkers, M., Hooijkaas, N., Verweij, P., Faaij, A. 2014. Comparative analysis of key socio-economic and environmental impacts of smallholder and plantation based jatropha biofuel production systems in Tanzania. *Biomass and Bioenergy*, *61*, 25–45. http://doi.org/10.1016/j.biombioe.2013.10.005

Van Eijck, J., Smeets, E., and Faaij, A. 2012. The economic performance of jatropha, cassava and Eucalyptus production systems for energy in an East African smallholder setting. *GCB Bioenergy*, *4*6, 828–845. http://doi.org/10.1111/j.1757-1707.2012.01179.x

Van Vliet, J. A., Schut, A. G. T., Reidsma, P., Descheemaeker, K., Slingerland, M., Van De Ven, G. W. J., and Giller, K. E. 2015. De-mystifying family farming: Features, diversity and trends across the globe. *Global Food Security*, *5*, 11–18. http://doi.org/10.1016/j.gfs.2015.03.001

Vang Rasmussen, L., Rasmussen, K., and Bech Bruun, T. 2012. Impacts of Jatropha-based biodiesel production on above and below-ground carbon stocks: A case study from Mozambique. *Energy Policy*, *51*, 728–736. http://doi.org/10.1016/J.ENPOL.2012.09.029

Veenendaal, E.M., Torello-Raventos, M., Feldpausch, T.R., Domingues, T.F., Gerard, F., Schrodt, F., Saiz, G., Quesada, C.A., Djagbletey, G., Ford, A., Kemp, J., Marimon, B.S.,

Marimon-Junior, B.H., Lenza, E., Ratter, J.A., Maracahipes, L., Sasaki, D., Sonké, B., Zapfack, L., Villarroel, D., Schwarz, M., Yoko Ishida, F., Gilpin, M., Nardoto, G.B., Affum-Baffoe, K., Arroyo, L., Bloomfield, K., Ceca, G., Compaore, H., Davies, K., Diallo, A., Fyllas, N.M., Gignoux, J., Hien, F., Johnson, M., Mougin, E., Hiernaux, P., Killeen, T., Metcalfe, D., Miranda, H.S., Steininger, M., Sykora, K., Bird, M.I., Grace, J., Lewis, S., Phillips, O.L., Lloyd, J. 2015. Structural, physiognomic and above-ground biomass variation in savanna–forest transition zones on three continents – how different are co-occurring savanna and forest formations? *Biogeosciences*, *12*10, 2927–2951. http://doi.org/10.5194/bg-12-2927-2015

Vermeulen, S., and Cotula, L. 2010. Over the heads of local people: consultation, consent, and recompense in large-scale land deals for biofuels projects in Africa. *Journal of Peasant Studies*, *37*4, 899–916. http://doi.org/10.1080/03066150.2010.512463

Vijay, V., Pimm, S. L., Jenkins, C. N., and Smith, S. J. 2016. The Impacts of Oil Palm on Recent Deforestation and Biodiversity Loss. *PLOS ONE*, *11*7, e0159668. http://doi.org/10.1371/journal.pone.0159668

von Maltitz, G. P., and Setzkorn, K. A. 2013. A typology of Southern African biofuel feedstock production projects. *Biomass and Bioenergy*, *59*, 33–49. http://doi.org/10.1016/j.biombioe.2012.11.024

von Maltitz, G. P., Gasparatos, A., Fabricius, C., Morris, A., and Willis, K. J. 2016. Jatropha cultivation in Malawi and Mozambique: impact on ecosystem services, local human well-being, and poverty alleviation. *Ecology and Society*, *21*3, art3. http://doi.org/10.5751/ES-08554-210303

von Maltitz, G., Gasparatos, A., and Fabricius, C. 2014. The Rise, Fall and Potential Resilience Benefits of Jatropha in Southern Africa. *Sustainability*, *6*6, 3615–3643. http://doi.org/10.3390/su6063615

Waha, K., Zipf, B., Kurukulasuriya, P., and Hassan, R. M. 2016. An agricultural survey for more than 9,500 African households. *Scientific Data*, *3*, 160020. http://doi.org/10.1038/sdata.2016.20

Walkley, A., and Black, I. A. 1934. An examination of the Degtjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. *Soil Science*, *37*1, 29–38. http://doi.org/10.1097/00010694-193401000-00003

Weeber, S. 2016. Nodes of resistance to green grabbing: a political ecology. *Environment and Social Psychology*, *1*2, 116–129. http://doi.org/10.18063/ESP.2016.02.006

Weisell, R., and Dop, M. C. 2012. The Adult Male Equivalent Concept and its Application to Household Consumption and Expenditures Surveys HCES. *Food and Nutrition Bulletin*, *33*3_suppl2, S157–S162. http://doi.org/10.1177/15648265120333S203

Wendimu, M. A. 2016. Jatropha potential on marginal land in Ethiopia: Reality or myth? *Energy for Sustainable Development*, *30*, 14–20. http://doi.org/10.1016/j.esd.2015.11.001

White, B., and Dasgupta, A. 2010. Agrofuels capitalism: a view from political economy. *The Journal of Peasant Studies*, *37*4, 593–607. http://doi.org/10.1080/03066150.2010.512449

White, B., Borras Jr., S. M., Hall, R., Scoones, I., and Wolford, W. 2012. The new enclosures: critical perspectives on corporate land deals. *Journal of Peasant Studies*, *39*3–4, 619–647. http://doi.org/10.1080/03066150.2012.691879

Wiggins, S., Henley, G., and Keats, S. 2015. *Competitive or complementary? Industrial crops and food security in sub-Saharan Africa*. London.

World Food Programme. 2008. *Food consumption analysis: Calculation and use of the food consumption score in food security analysis*. Rome.

Yaro, J. A. 2009. Customary tenure systems under siege: contemporary access to land in Northern Ghana. *GeoJournal*, *75*2, 199–214. http://doi.org/10.1007/s10708-009-9301-x

Yaro, J. A., and Tsikata, D. 2013. Savannah fires and local resistance to transnational land deals: the case of organic mango farming in Dipale, northern Ghana. *African Geographical Review*, *32*1, 72–87. http://doi.org/10.1080/19376812.2012.759013

Yaro, J. A., Teye, J. K., and Torvikey, G. D. 2017. Agricultural commercialisation models, agrarian dynamics and local development in Ghana. *The Journal of Peasant Studies*, *44*3, 538–554. http://doi.org/10.1080/03066150.2016.1259222

Yi, C., Reddy, C., Varghese, K., Bui, T., Zhang, S., Kallath, M., Kunjachen, B., Ramachandran, S., Hong, Y. 2014. A New Jatropha curcas Variety JO S2 with Improved Seed Productivity. *Sustainability*, *6*7, 4355–4368. http://doi.org/10.3390/su6074355

Zhang, W., Liu, K., Wang, J., Shao, X., Xu, M., Li, J., Wang, X., Murphy, D. V. 2015. Relative contribution of maize and external manure amendment to soil carbon sequestration in a long-term intensive maize cropping system. *Scientific Reports*, *5*1, 10791. http://doi.org/10.1038/srep10791

Zoomers, A. 2010. Globalisation and the foreignisation of space: seven processes driving the current global land grab. *The Journal of Peasant Studies*, *37*2, 429–447. http://doi.org/10.1080/03066151003595325