EXPANDING THE LIMITS OF COMMUNITY-LED BIODIVERSITY MONITORING OF ANTHROPOGENIC PRESSURES IN KEY BIODIVERSITY AREAS IN GHANA

COMMUNITY-LED

INDEPENDENT REPORTING

Policy Paper , 07-23

TESTING THE LONG-TERM APPLICABILITY OF TIMBY MOBILE APPLICATION TO DELIVER A COMBINED AGRO-ECOLOGY AND SOIL FERTILITY ADVISORY SERVICE FOR BIODIVERSITY CONSERVATION WITHIN PROTECTED LANDSCAPES

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Background

There is increasing recognition of the interconnectedness of biodiversity loss, climate change and agricultural practices or agricultural intensification. Existing evidence indicates that ecosystems with low biodiversity are less resilient and more vulnerable to the effects of climate change[1]. Also, recent IPCC (AR6 WGII) report establish a clear causal relationship between climate change biodiversity loss, and a high confidence that human activities such agriculture constitutes a primary driver of both climate change and biodiversity loss[2]. The European Green Deal (EGD) further highlights this relationship indicating that the main drivers of biodiversity loss include the change in land and sea use, natural resources direct exploitation and climate change[3]. The agriculture sector contributes 19%–29% of global anthropogenic greenhouse gas (GHG) emissions, and will need to reduce emissions significantly by 2030 in order to achieve the global goal of limiting warming to 2o Celsius[4]. In Africa, agriculture is a key interlinking factor driving the dual crisis of biodiversity loss and climate change. Regionally, already the impacts of climate change are becoming evident in crop, livestock and fisheries systems sub-sectors. In Ghana, it has been observed[5] that the country continues to experience extensive biodiversity loss, primarily as a result of economic development, especially through unsustainable agricultural practices and natural resource extraction. At the protected landscape level, recently observed environmental challenges confronting most landscapes include increasing habitat destruction due to uncontrolled logging for charcoal production, excessive hunting, incessant wildfires, illegal gold mining; unsustainable farming practices; increasing use of agrochemicals, reduction in soil fertility, rarity, and loss of flora and fauna[6]; inadequate livelihood support systems, and weak institutional capacity to support

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[1] Muluneh, M.G. Impact of climate change on biodiversity and food security: a global perspective—a review article. *Agric & Food Secur* **10**, 36 (2021). https://doi.org/10.1186/s40066-021-00318-5
Njoroge JM. Climate change-perceived impacts, risks, vulnerability, and response strategies: A case study of Mombasa coastal tourism, Kenya. African J Hosp [Internet]. 2015;4:1_32. Available from: http//:www.ajhtl.comhttp://s1.reutersmedia.net/resources/r/m=02&d=2121012&t=2&i=662769753&w=580&fh=&fw=&ll=&pl=&r=ALNE89B1A.
https://www.wur.nl/en/show/biodiversity-loss-and-climate-change-two-mutually-reinforcing-crises.htm

[2] IPCC, 2022: Summary for Policymakers [H.-O. Pörtner, D.C. Roberts, E.S. Poloczanska, K. Mintenbeck, M. Tignor, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem (eds.)]. In: Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 3–33, doi:10.1017/9781009325844.001.

[3] European Commission 2019: Communication on the EGD

[4] World Bank: https://www.worldbank.org/en/topic/climate-smart-agriculture

[5] Ministry of Environment, Science, Technology, and Innovation (MESTI), National Biodiversity Policy, (2021).

[6] UNEP: https://sgp.undp.org/spacial-itemid-projects-landing-page/spacial-itemid-project-search-results/spacial-itemid-project-detailpage.html?view=projectdetail&id=30052
Weiskopf SR, Rubenstein MA, Crozier LG, Gaichas S, Griffis R, Halofsky JE, et al. Climate change effects on biodiversity, ecosystems, ecosystem services, and natural resource management in the United States. Sci Total Environ. 2020;733:137782.

conservation and production[7]. The results of these environmental abuses have been the increasing loss of biodiversity and the destruction of mountain forest resources and vegetation cover, dryness of water sources, land degradation, and widespread poverty. This research is an effort to shed further light on the intricate relationships between biodiversity loss, climate change and agricultural practices or agricultural intensification and the role of socially innovative models in addressing existing gaps at the local level.

It makes use of an outcome mapping[8] of biodiversity monitoring schemes sourced from several monitoring projects and programmes databases within the Mole Ecological Landscape (MEL) and the Keta Lagoon Complex Ramsar Site (KLCRS). Observations from the outcome mapping is then used to frame a community-based action learning workshop on independent monitoring and reporting on the current drivers of biodiversity decline using TIMBY mobile application[9]. TIMBY is demonstrably a more community responsive, simple-to-use toolbox that can facilitate the co-creation, exploration, experimentation and evaluation of innovative ideas, scenarios, concepts and related innovation deployment with high relevance to mainstreaming local capacities for biodiversity monitoring.

Conservation Values of The Mole Ecological Landscape

Mole National Park covers approximately 4,840 km2 and is the largest and most prestigious protected area in Ghana under the guidance of the Wildlife Department. Mole National Park was the first Wildlife Protected Area to be established in Ghana. The Park lies within two physiographic regions - 65% lies within the Voltaian sandstones basin and 35% within the savannah high plains. The topography is generally undulating with flat topped hills which is dominated by the Konkori scarp that runs north-south through the park and reaches up to250m a.m.s.1. The Park forms part of the Volta River catchment and numerous rivers cross or originate in it to drain into the White Volta River. Mole National Park represents a fairly undisturbed guinea Savannah ecosystem dominated by open savannah woodland. The park has very rich flora and fauna. Over 93 species of mammals, about 400 species of birds, 9 amphiblan, 33 reptilian and several insectivorous species and 5 endemic butterfly species have been recorded. Species of special interest include Elephant, Buffalo, Kob, Western Hartebeest, Roan Antelope, Defassa Waterbuck, Oribi, Bohor Reedbuck and Red-flanked Duiker. The riverine forests are home to rare and endangered species such as Yellow-backed Duiker and Black and White Colobus monkey. The Lion, Leopard and Hyena

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[7] UNEP: https://sgp.undp.org/spacial-itemid-projects-landing-page/spacial-itemid-project-search-results/spacial-itemid-project-detailpage.html?view=projectdetail&id=30052

[8] Research to Action: https://www.researchtoaction.org/2012/01/outcome-mapping-a-basic-introduction/

[9] TIMBY:
https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwjnhLLylYz_AhWBUMAKHUS6C4IQFnoECAgQAQ&url=https%3A%2F%2Ftimby.org%2F&usg=AOvVaw1B1M6_3IJZZwYe5B2_mqP

are important large carnivores found in the reserve. The baffalo population is of great scientific interest since both black and red colour varieties exist in the Dark. With regards to vegetation, local endemism is generally low in West African Savannah, and only two endemic species Kyllinga echinata, a sedge and Ancilema setiferum var pallidiciliatum confined to northern Ghana, are found in Mole. In addition, three species endemic to Ghana are recorded, namely Gongronema obscurum, Raphionacme vignei and Phinopterys angustifolia. Eleven (11) species of mole are confined to the savannah woodland while Mimusops kammel, a tree that is confined to riverine forests. To date, five species have been identified which have not been recorded elsewhere in Ghana; Croton pseudopulchellus, Indigofera conferta, Indigoera trichopoda, Jatropha neriifolia and Pleiotaxis newtonii. Anthocleista vogelii, a tree of wet sites in the south-western forest zone of Ghana has been recorded for the first time in Mole. Apodostigma palleus is a climber that is also restricted to the forests in the south-west Ghana. Amblygono carpas andogeneiss, a savannah tree widespread in central, east and south tropical Africa, has been recorded for the first time in Ghana at Mole. Mole has an important history linked to the national slave trade route project. The ancient caravan route from Salaga to Wa and beyond to Mali, passed through the heart of the park. This route was used for both trading and to transport slaves to coastal markets. There is a cave in the Konkori escarpment that was used as a refuge from slave raiders by the local indigines. Other important attractions in the Park include Kwomwoghlugu and Asibey pools, wetland areas (unique bird-watching sites), waterfalls on the Koukori escarpments and remains of many old villages destroyed by slave raiders.

Mole National Park is fringed by 33 farming communities, which lie within a five kilometre radius from the Park. They are in five districts, four of which are in the Northern Region, with one in the Upper West Region. Communities living across this savannah landscape are closely dependent on local natural resources. Agriculture and livestock rearing are the major source of employment and people collect non-timber forest products (NTFPs), wild fruits and nuts like Shea and DawaDawa.

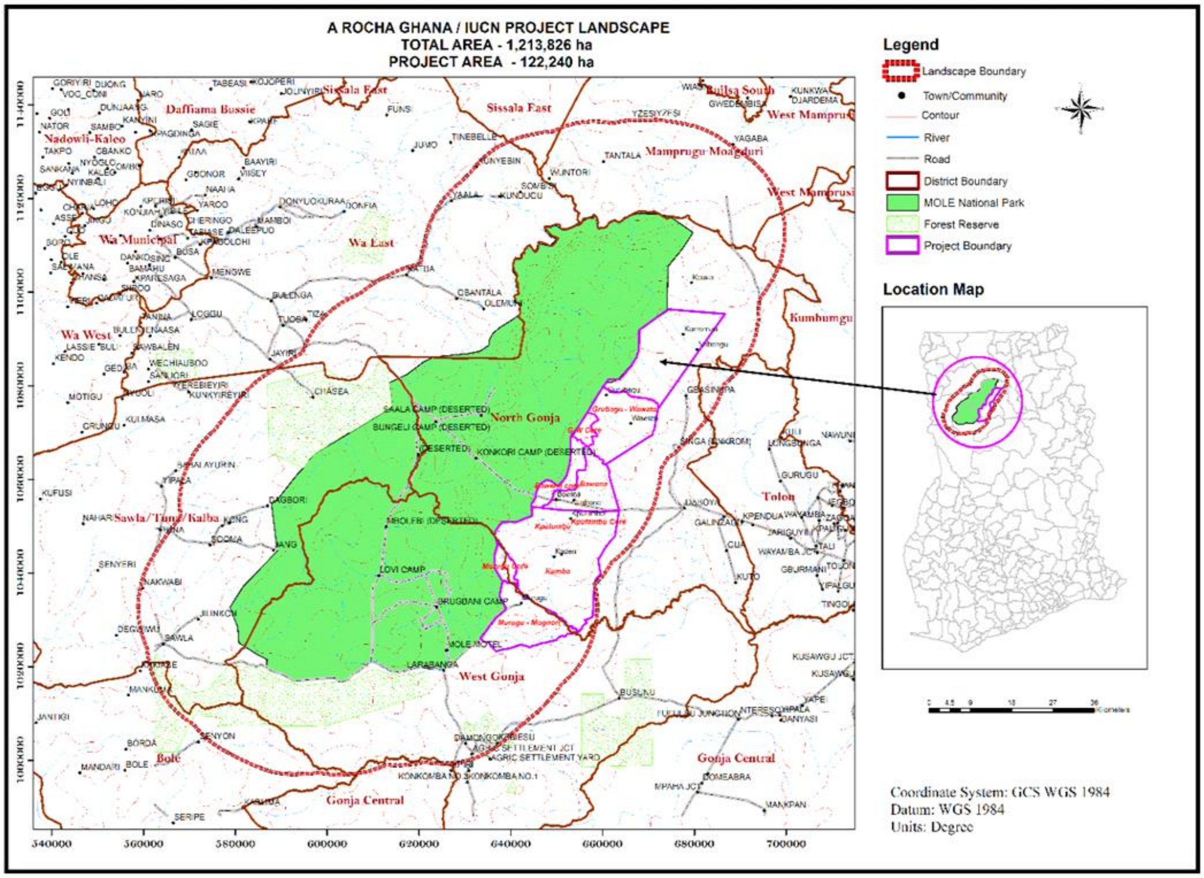

Figure 1.2: The Mole Ecological Landscape
Source: A Rocha Ghana/IUCN Project

Monitoring Current Drivers of Biodiversity Loss in Mole Ecological Landscape (MEL)

This research project established a Resident Sustainability Teams (RST) consisting of 15 community members from 7 communities in MEL, namely; Kabape, Kananto, Mognori, Larabanga, Murugu, Nagori and Yipala communities. These RSTs were equipped through field-based training to monitor, record and share drivers of biodiversity decline and threads of sustainability (micro actions of conservation with landscape-wide impact), using a set of icon-based communication tools within the TIMBY mobile application package.

Between August, 2022 and April 2023, the RST monitored the MEL for various drivers of biodiversity loss/decline. The most observed and recorded drivers included bush fires, charcoal burning, cattle grazing and poor farming practices. Table 1.1 presents the list of observations for the period. A total of 230 incidents were observed and reported for the period. Out of these, 18.3% were cases of bush fires, 25.7% were cases of charcoal burning, 33% were cases of cattle grazing and 23% were cases of poor farming practices. It was further observed that cases of bush fires, charcoal burning and cattle grazing were mostly prevalent between Nov-April. Only cases of poor farming practices were most prevalent between March-Sept. An interesting noted was that all of these drivers were human activity-led, periodic/seasonal, with their effects on biodiversity loss compounding and cascading beyond the landscape due to poor climate adaptation capacities. It was also noted that farmers in the MEL are attempting to modify their practices in order to deal with climate change and variability through various conservation practices. Yet there were also high concerns of climate induced cases of loss and damage as both soft adaptation limits and hard adaptation limits are within reach in the MEL.

Table 1.1 Current Drivers of Biodiversity Loss

Drivers	Aug	Sept	Oct	Nov	Dec	Jan	Feb	March	April	Total/ Drivers
Bush fires	0	1	1	5	9	13	7	3	3	42
Charcoal burning	2	2	2	8	11	10	12	8	4	59
Cattle Grazing	5	5	6	8	15	10	10	11	6	76
Poor farming Practices	3	5	5	3	1	3	7	12	14	53
Total/Month	10	13	14	24	36	36	36	34	27	230

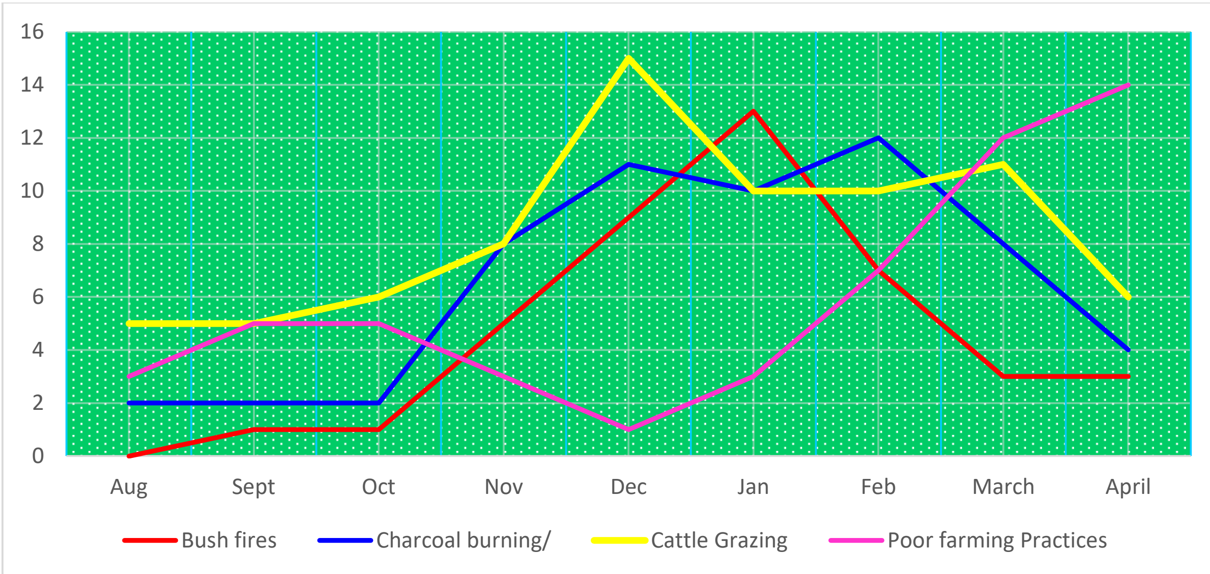

Figure 1.1: Current Drivers of Biodiversity Loss in MEL

Testing the Long-Term Feasibility of Community-Led Agro-Ecology and Soil Fertility Advisory Services with TIMBY Mobile Applications Package

An intentional design process was adopted to gain "actionable human insight" from a total of 30 in-depth interviews on long term capacity required for real-time monitoring of the full impact of anthropogenic pressures, ensuring 50%+ representation of women to ensure gender equity. Two field-based workshops were organized in MEL involving 30 participants from the 7 selected communities to test the selected conservation actions with direct boundary partners.

Between August, 2022 and April 2023, the RST monitored the conservation practices in the MEL, observing building cases of for crop-livestock integration, agroforestry (in shea landscapes), agro-waste valourization, biointensive agriculture[10] and integrated pest management. A total of 118 farm plots were observed (see table 1.2). Out of the of the total observations, 39% were practiced crop-livestock integration, 29.7 % practiced agroforestry, 19.5% practiced agro-waste production and use, 4.2% practiced biointensive agriculture of and 7.6% practiced integrated pest management. It was noticed that most of these practices were still rudimentary, requiring technical guidance. Based on the perspectives of the local farmers, the observed practices were

[10] Grow Biointensive:
https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwiG1q7VlIz_AhVSh1wKHeN2AI4QFnoECA4QAQ&url=http%3A%2F%2Fwww.growbiointensive.org%2FPDF%2FBiointensiveAgricultureAGreenerRevolution_English.pdf&usg=AOvVaw1OCRXgZjNHJ0gXOyhInic4

rated in terms of the conservation value of each practice. Biointensive agriculture recorded the highest conservation value of 9.5. However, it also recorded the lowest average plot size of 2.5 hectares. It was noted that Crop-livestock integration and Agroforestry were the most dominant practices with an observed number of farm plots of 46 plots and 35 plots respectively. Though agro-waste valourization was rated high *(second)* in terms of conservation value in the MEL, only 19.5% farm plots recorded practices of agro-waste valourization. By inference, more than 80% of farmers in the MEL either relied on synthetic fertilizer application or do not use any form of soil fertility inputs. Figure 1.3 portrays a stark picture of the direction of agriculture intensification in the MEL.

Table 1.2: Sustainability Weights Of On-Farm Of Key Conservation practices

On-Farm Of Key Conservation practices	Average plot size	Number of Farm plots	Average conservation weight
Biointensive agriculture	2.5	5	9.5
Crop-livestock integration	4	46	8
Agroforestry	3	35	7
Agro-waste valourization	3	23	9
Integrated Pest Management	3	9	6

Average conservation scale of 0-10 based on farmer perceptions, where 0=no conservation value, and 10=highest conservation value

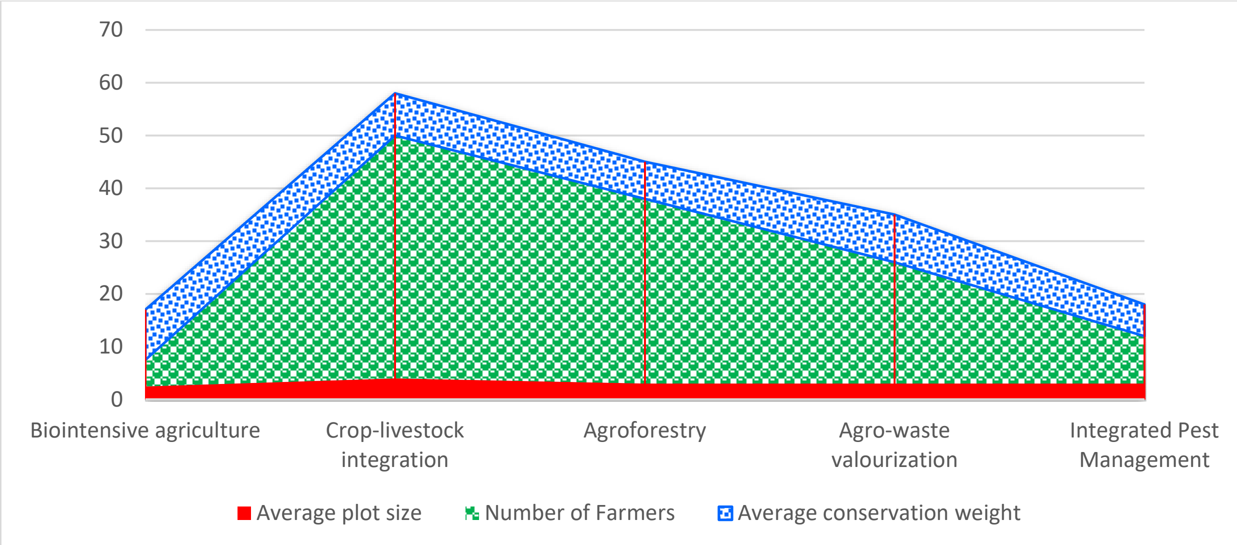

Figure 1.3 Direction Of Agriculture Intensification In The MEL

This field-based capacity building adopted a learning-by-doing approach to co-define the community-led conservation actions that directly mitigate the observed drivers of biodiversity loss or correlates with a long term capacity required for real-time monitoring of the full impact of anthropogenic pressures, and feeding such capacity into technology-aided agro-ecology and soil fertility advisory service, the Post-2020 Biodiversity Framework[11], the strategic objectives of Ghana's National Biodiversity Strategy and Action Plan as well as the SDGs. This involved in-depth interviews exploring the following conservation actions:

1. Innovation Platforms for agroforestry practices
2. Innovation Platforms for Combined agro-ecology and soil fertility advisory service
3. Community Action Learning on Crop Livestock Integration in Ecological Organic Agriculture

Innovation Platforms on Agroforestry Practices in MEL

It was observed that 40% of farmers were already practicing agroforestry by planting fruit trees on their farms. However, this was on a very small scale and the approach was quite rudimentary. It was noted that several agroforestry projects have been introduced in northern Ghana to

[11] Convention on Biological Diversity: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwiW-eWolYz_AhVhoFwKHXOyCLYQFnoECBQQAQ&url=https%3A%2F%2Fwww.cbd.int%2Fdoc%2Fc%2F409e%2F19ae%2F369752b245f05e88f760aeb3%2Fwg2020-05-l-02-en.pdf&usg=AOvVaw0Re0COCz35TzeEaFjrqc25

improve savannah woodland and agroforestry management practices while strengthening tree-based income generation for local communities. Mostly, agro forestry projects involved capacity building and provision of inputs for tree planting and on-farm tree management. About 60% of community members engaged had been trained and provided with technical assistance and knowledge to support restoration to enable them become climate resilient and productive through agroforestry. However, post intervention monitoring of agroforestry activities was close to zero. This is the gap which the TIMBY mobile application can be deployed to fill creating a dual information sharing platform for agricultural extension service officers and local farmers to monitor and advice on post planting activities in agro-forestry projects. Field observation indicates that effective field application will require actively involvement of key stakeholders including farmers, extension officers, agriculture departments, district assemblies, meteorological departments, environmental protection agency, forestry commission, water resources commission, sector ministries, and civil society organisations in the design of the farming systems (co-creation), implementation and management. Field data can be co-generated by trained community-based Monitors working in collaboration with Park Managers, Range Officers and Agricultural Extension Service Officers to verify, validate and share the data in the form of written report, video or audio reports using a combination of the TIMBY mobile application lined to the online database.

Innovation Platforms for Combined Agro-Ecology and Soil Fertility Advisory Service

Based on the observation that most of drivers of biodiversity decline is human driven, the real threat climate induced loss and damage in the MEL and the socio-technical feasibilities of TIMBY for advancing agroecological practices, it is preferable to identify other technologies or technical support systems that can catalyze the capitalization of mobile based applications as a toolbox for promoting integrated biodiversity conservation. Using community-led approaches, local communities can become change agents for ecological restoration, ecological connectivity and climate resilience building in National Parks and Ramsar Sites in Ghana. This requires reinforcement of the existing community-based tools such as agro-forestry, establishment of woodlots, biointensive agriculture. The combination of Remote Sensing/GIS technology with the TIMBY Mobile application noted as a practically feasible platform to advance spatial and temporal change detection analysis in Ramsar Sites and National Parks. Interactions with researchers from CIFOR-ICRAF indicates that the Participatory Integrated Climate Services for Agriculture (PICSA) can be extremely congenial with TIMBY.

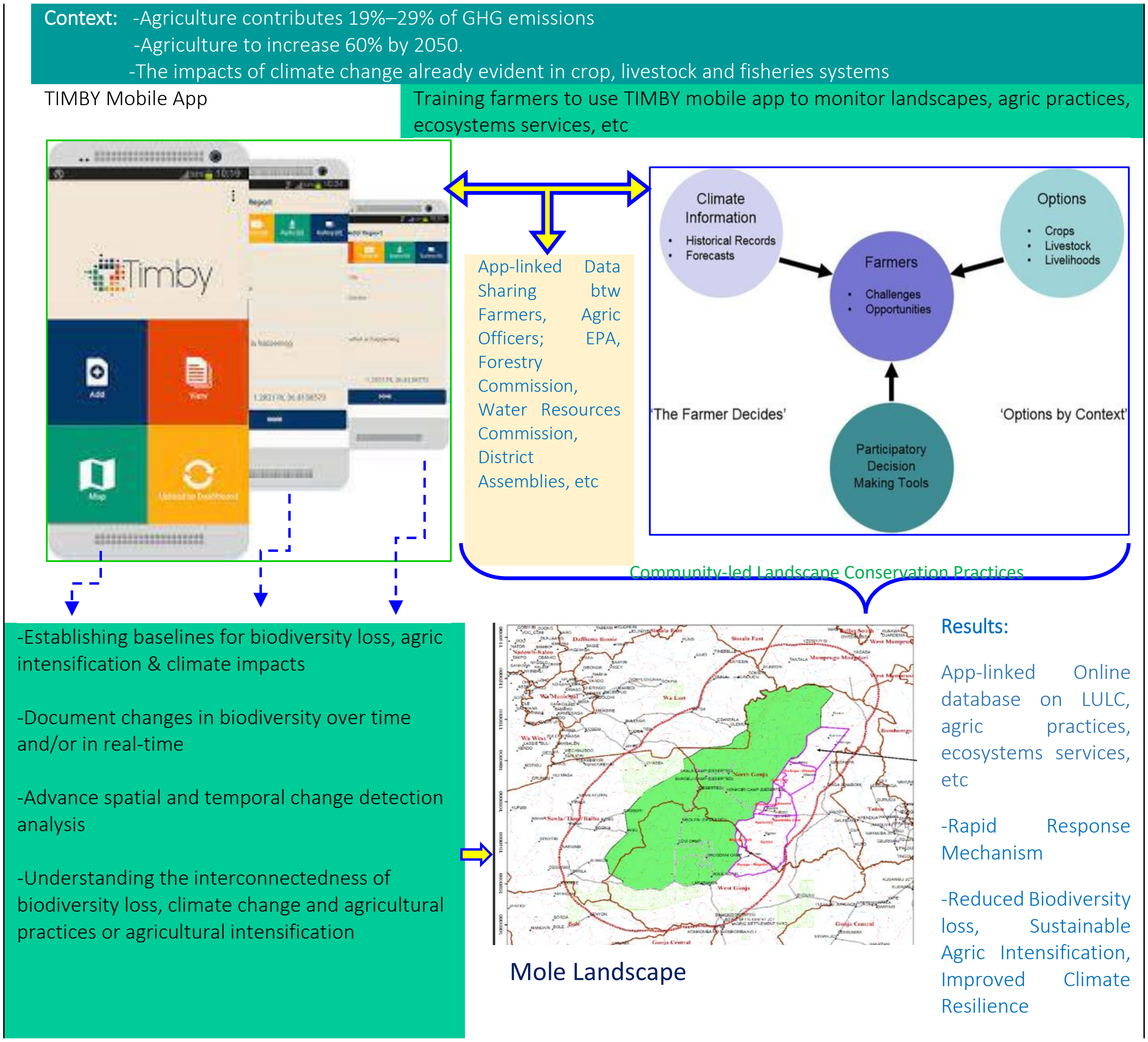

Fig. 1.4: Conceptual Framework for Innovation Platforms for Combined Agro-Ecology and Soil Fertility Advisory Service linking PICSA and TIMBY Mobile Application

PICSA is built on an experimental model where agriculture extension officers working with groups of farmers before the agricultural season to firstly analyse historical climate information, develop resource maps combined with participatory tools to develop and choose crop, livestock and livelihood options best suited to individual farmers' needs. Then soon before and during the season extension officers and farmers consider the practical implications of seasonal and short-term forecasts on the plans farmers have made. Combining the analytical and reporting functions of TIMBY with the seasonal and short-term forecasts component in PICSA will create an innovative platform for agriculture extension officers to advance a combined agro-ecology and soil fertility advisory service, with PICSA providing the technical knowledge while TIMBY mobile application provides a dual information exchange between farmers and agriculture extension officers. PICSA model could be far reaching in terms of delivering conservation values in the MEL when combined with mobile applications with an online data base such as TIMBY.

Community Action Learning on Crop Livestock Integration in Ecological Organic Agriculture:

Field-based testing of TIMBY with 30 participants from the 7 communities in MEL observed that TIMBY mobile application is practically useful:

a) Facilitate remote monitoring and advisory services on soil fertility management technologies; high community relevance, high conservation value for landscapes *(see table 1.2)*

b) Facilitate remote monitoring and advisory services on integration of livestock in food crop farming system; high community relevance, high conservation value for landscapes *(see table 1.2)*

c) Facilitate remote monitoring and advisory services on conservation of soil moisture; medium community relevance, high conservation value for landscapes *(see table 1.2)*

These farming systems will contribute to reducing the pressure on the environment (i.e charcoal production and yearly burning of the vegetation to generate fresh grasses for livestock grazing). The recently added TIMBY analytics on dashboard will be useful in triaging on-farm micronized factors providing a dual feedback between farmers and agriculture extension service officers including:

a) Impacts of the farming systems on agricultural productivity.
b) Yields, nutrient use efficiency and balance, soil fertility, water conservation, and availability.
c) Growth rates and reproductive rate of livestock.

The TIMBY Analytics on Dashboard feature allows users to generate graphs and charts that provide better insight into the data displayed for end-users and policy makers. It also allows users to choose from a range of different options to customize the types of graphs and charts that are created and to tailor the analytics to meet the specific needs of stakeholders, thereby gaining deeper insights into the data captured.

The Community Action Learning observed that TIMBY has a high digital potentials and feasibilities for reducing pesticide pollution and Integrated Pest Management: Interaction with farmers demonstrated botanical pesticides are gaining popularity among farmers in the MEL. Yet the success levels still remain undeveloped. TIMBY is demonstrably applicable for agriculture extension service officers and local farmers to monitor and report industrial pesticide pollution and contamination of food crops, animal feed, and their impact on the environment.

Long-Term Capacity for Realtime Monitoring Requires Socially Innovative Models in Biodiversity Conservation

In spite of these potentials, the community action learning platforms revealed logistical, socio-technical, -political, -environmental, -economic and -cultural limitations remain. These limitations could hinder any efforts towards long term capacity for realtime monitoring of biodiversity loss or conservation. A long term capacity for realtime monitoring requires focusing attention strategically on connecting and building alliances between local communities, research community and grassroots civil society organisations to promote systemic policy shifts, placing emphasis on radical system change, integrated biodiversity conservation and community-led action guided by socially innovative models (SIM) or human-centred design (HCD). HCD builds upon participatory action research as a creative problem-solving process that focuses on people's practices, needs and preferences. From these field observations, we recommend recognizing biodiversity conservation as deeply social challenge which requires the centralization of local communities and mainstreaming the socio-technical challenges, opportunities and capacities that shape everyday conservation practices of farmers and fringe communities into policy implementation including the Post-2020 Biodiversity Framework and the SDGs 14 and 15. Such socially innovative models of biodiversity conservation will help connect a range of academic and third-sector stakeholders including local communities, civil society networks, grassroots and community-Based Organisation, women's associations, youth groups, community resource management associations, and local government authorities in Ghana link their capacities to implementation processes of the Post-2020 Biodiversity Framework and the SDGs 14 and 15. It will also help connect the technical aspects of realtime monitoring of biodiversity loss with social aspects, providing an interdisciplinary socio-technical understanding of conservation, based on knowledge exchange between local communities towards effective policy implementation, particularly, the Post-2020 Biodiversity Framework and the SDGs 14 and 15.