

# Evaluating the Sustainability of Maize-Legume Strip Cropping Technology in the Context of Smallholder Farmers in Northern Ghana

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## Introduction

Agricultural intensification, producing more output per unit area of land through efficient use of resources, has increased production of food by smallholder farmers in West Africa including Ghana. However, there is limited information on the sustainability of agricultural technologies promoted to intensify smallholder cropping systems. A 3-year (2014-2016) on-farm study was conducted to evaluate the sustainability of maize-legume strip cropping in northern Ghana.



Photo 1. Maize-cowpea (left) and maize-groundnut (right) strip cropping.

## Materials and Methods

-Four strip cropping options: two rows of maize (M) and two rows of cowpea (C) or groundnut (G) (2M:2C and 2M:2G) and two rows of M and four rows of C or G (2M:4C and 2M:4G) and sole cropping of each crop were laid-out in a randomized complete block design with five replications.

-The Sustainable Intensification Assessment Framework (SIAF, Musumba et al., 2017) was used to assess the sustainability of the above treatments.

-Application process of SIAF:

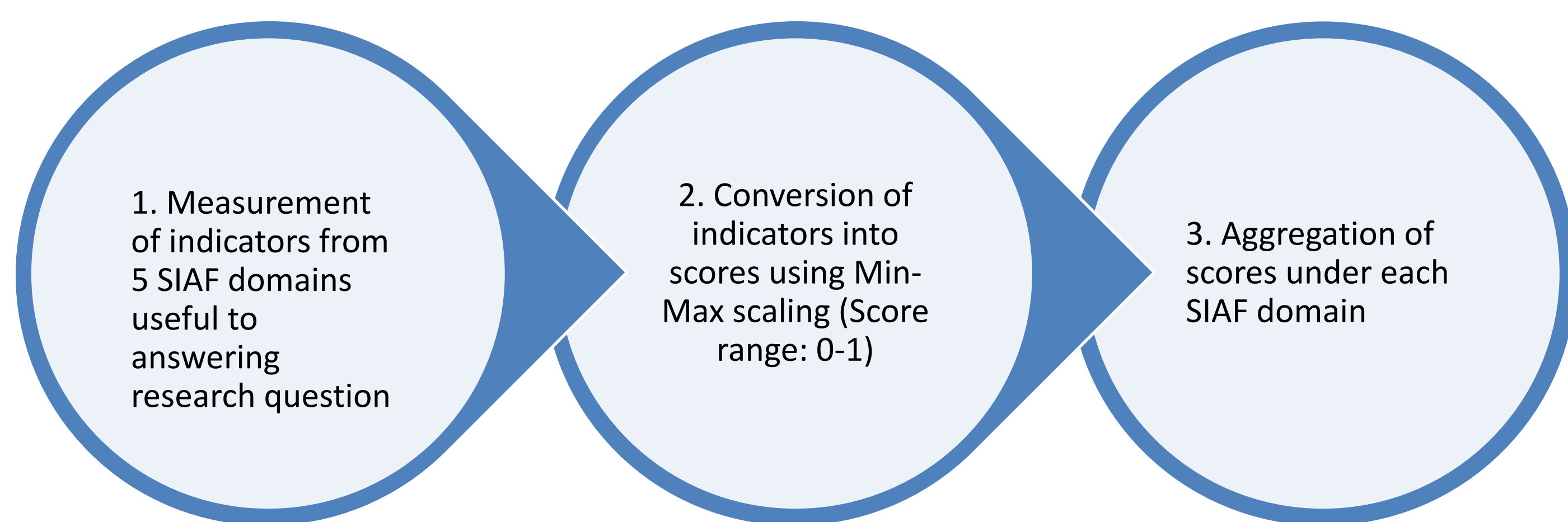
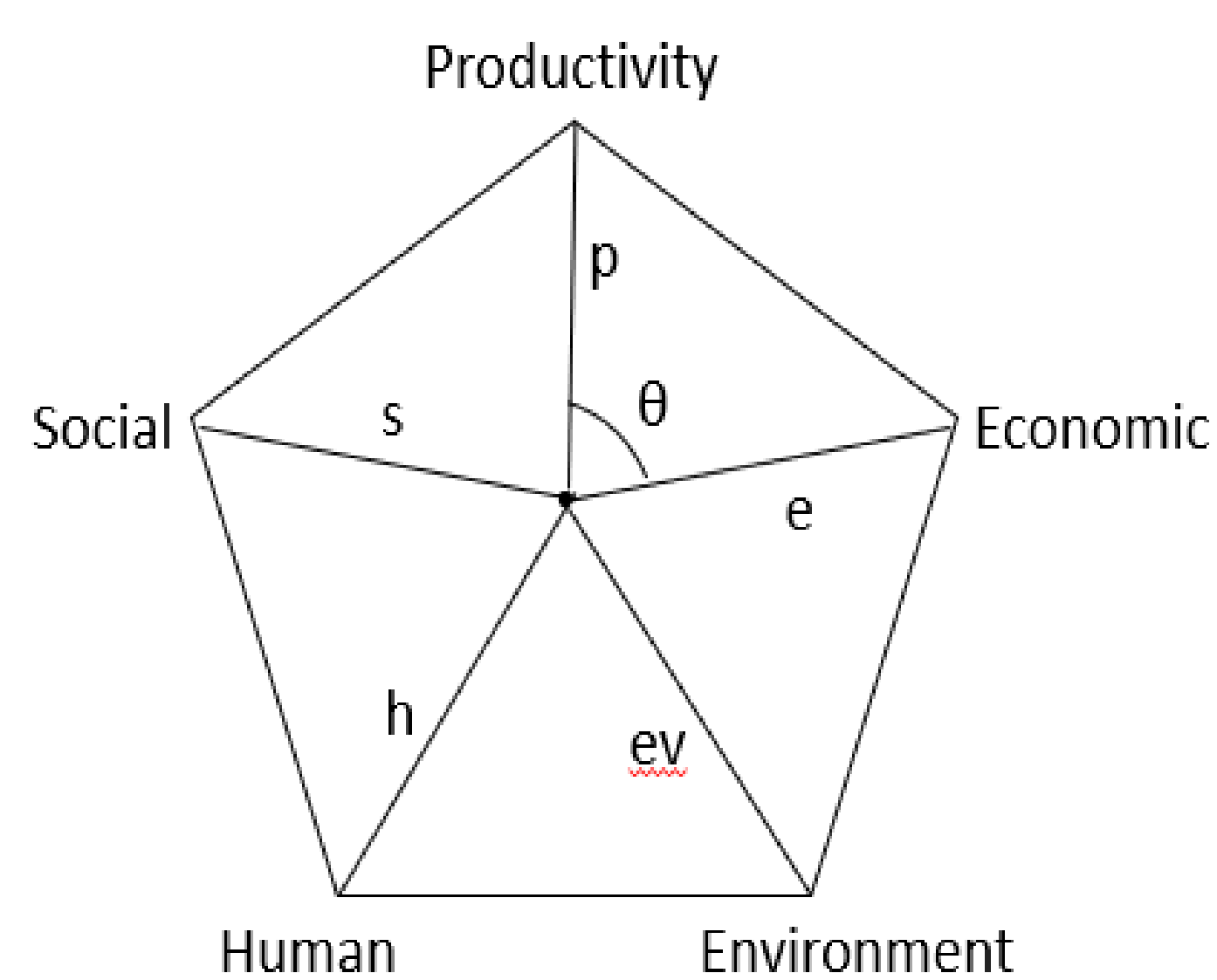


Figure 1. Application process of SIAF

-Sustainability indexing:



$$SI = \frac{1}{2} \sin \theta (pe+eev+evh+hs+ps),$$

$$\text{where } \theta = \frac{2\pi}{5} = \frac{360}{5} = 72,$$

$$SI = \frac{1}{2} \sin 72 (pe+eev+evh+hs+ps),$$

$$SI = \frac{\sqrt{10 + 2\sqrt{5}}}{8} (pe+eev+evh+hs+ps)$$

Figure 2. Estimation of sustainability index

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## Results

Table 1. Effect of maize-legume strip cropping on measured indicators of sustainable intensification in northern Ghana.

| Indicator by domain          | Metrics  | M <sup>a</sup> | C <sup>b</sup> | G <sup>c</sup> | 2M:2C  | 2M:2G  | 2M:4C  | 2M:4G  | Data sources        |
|------------------------------|--|----------------|----------------|----------------|--------|--------|--------|--------|---------------------|
| <b>Productivity</b>          |  |                |                |                |        |        |        |        |                     |
| Crop productivity            | Grain yield (kg/ha)                              | 3725.9         | 640.0          | 723.8          | 3903.7 | 4088.5 | 3610.0 | 3986.1 | Field               |
|                              | Land equivalent ratio                            | -              | -              | -              | 2.2    | 1.8    | 2.1    | 1.9    | Field               |
| <b>Economic</b>              |  |                |                |                |        |        |        |        |                     |
| Profitability                | Net income (GHS <sup>d</sup> /ha)                | 1062.9         | 48.7           | 703.8          | 1952.7 | 2527.5 | 1924.5 | 2636.7 | Field               |
| Variability of profitability | Variability of net income                        |                |                |                |        |        |        |        |                     |
|                              | < 0% net income                                  | 13.3           | 76.7           | 30.0           | 16.7   | 13.3   | 0.0    | 0.0    | Field               |
|                              | ≤ 50% net income                                 | 56.7           | 13.3           | 23.3           | 16.7   | 13.3   | 16.7   | 6.7    | Field               |
|                              | > 50% net income                                 | 30.0           | 10.0           | 46.7           | 66.7   | 73.3   | 83.3   | 93.3   | Field               |
| <b>Environment</b>           |  |                |                |                |        |        |        |        |                     |
| Soil chemical quality        | N <sub>2</sub> fixed by legume (kg/ha)           | -              | 24.0           | 21.0           | 17.0   | 17.0   | 21.0   | 19.0   | Kermah et al., 2018 |
| Light for photosynthesis     | Photoactive radiation (%)                        | 51.0           | 74.0           | 66.0           | 56.0   | 59.0   | 65.0   | 63.0   | Kermah et al., 2017 |
| <b>Human</b>                 |  |                |                |                |        |        |        |        |                     |
| Food security                | Calorie production (kcal/ha, x 10 <sup>4</sup> ) | 1359.9         | 215.0          | 410.4          | 1406.3 | 1608.5 | 1295.9 | 1575.7 | Field               |
| Nutrition                    | Protein production (g/ha, 10 <sup>2</sup> )      | 3509.8         | 1505.3         | 1867.5         | 4579.1 | 4793.7 | 4456.9 | 4734.2 | Field               |
| <b>Social</b>                |  |                |                |                |        |        |        |        |                     |
| Gender equity                | Technology rating by gender                      |                |                |                |        |        |        |        |                     |
|                              | Female (%)                                       | 10.4           | 12.5           | 13.5           | 4.2    | 21.9   | 7.3    | 30.2   | Field               |
|                              | Male (%)   | 11.9           | 7.1            | 3.1            | 36.7   | 41.2   | 0.0    | 0.0    | Field               |

<sup>a</sup>Maize, <sup>b</sup>Cowpea, <sup>c</sup>Groundnut and <sup>d</sup>Ghana Cedi (1€ = 6.9GHS, Bank of Ghana, 2021)

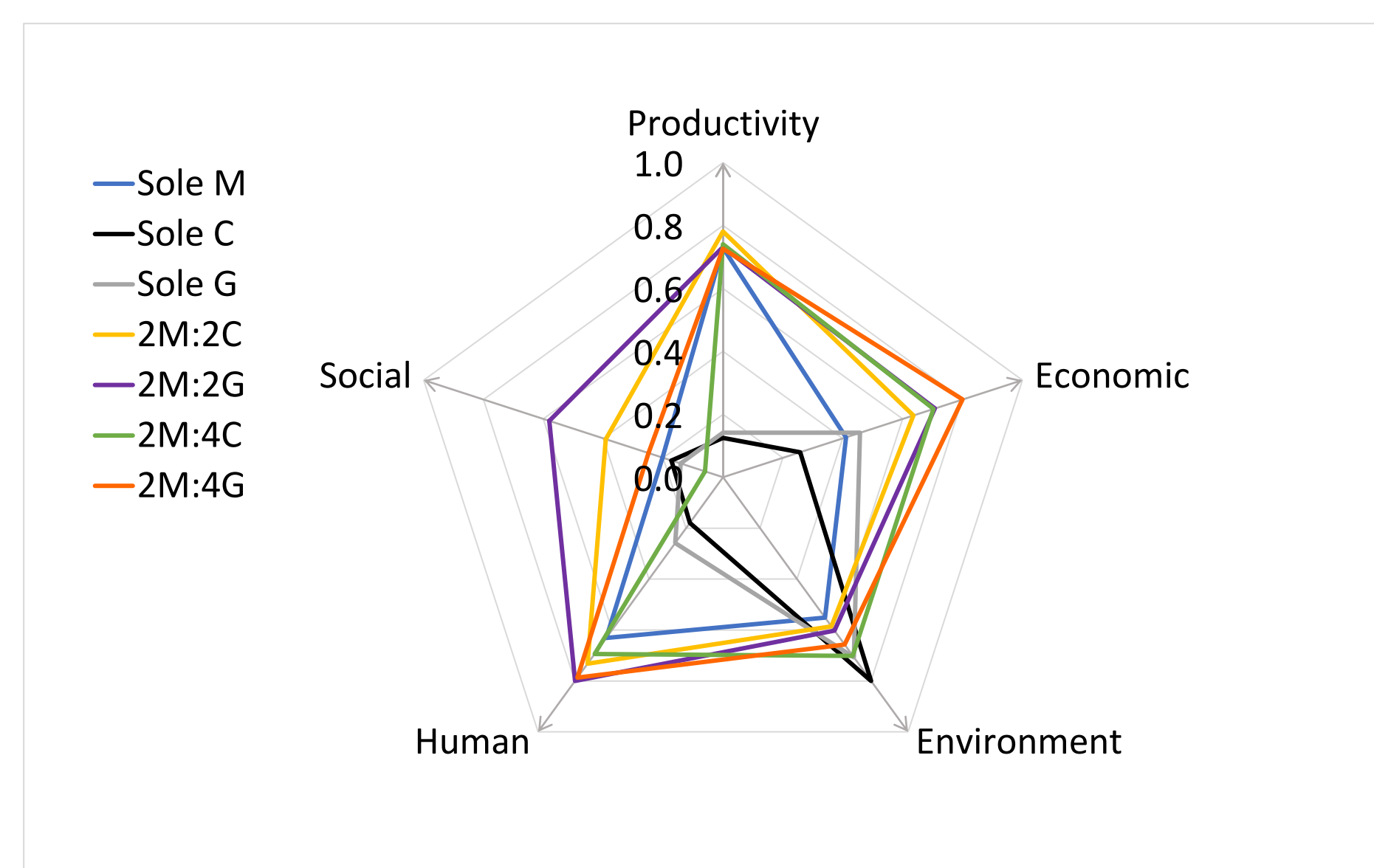


Figure 3. Sustainable intensification scores as affected by maize-legume strip cropping.

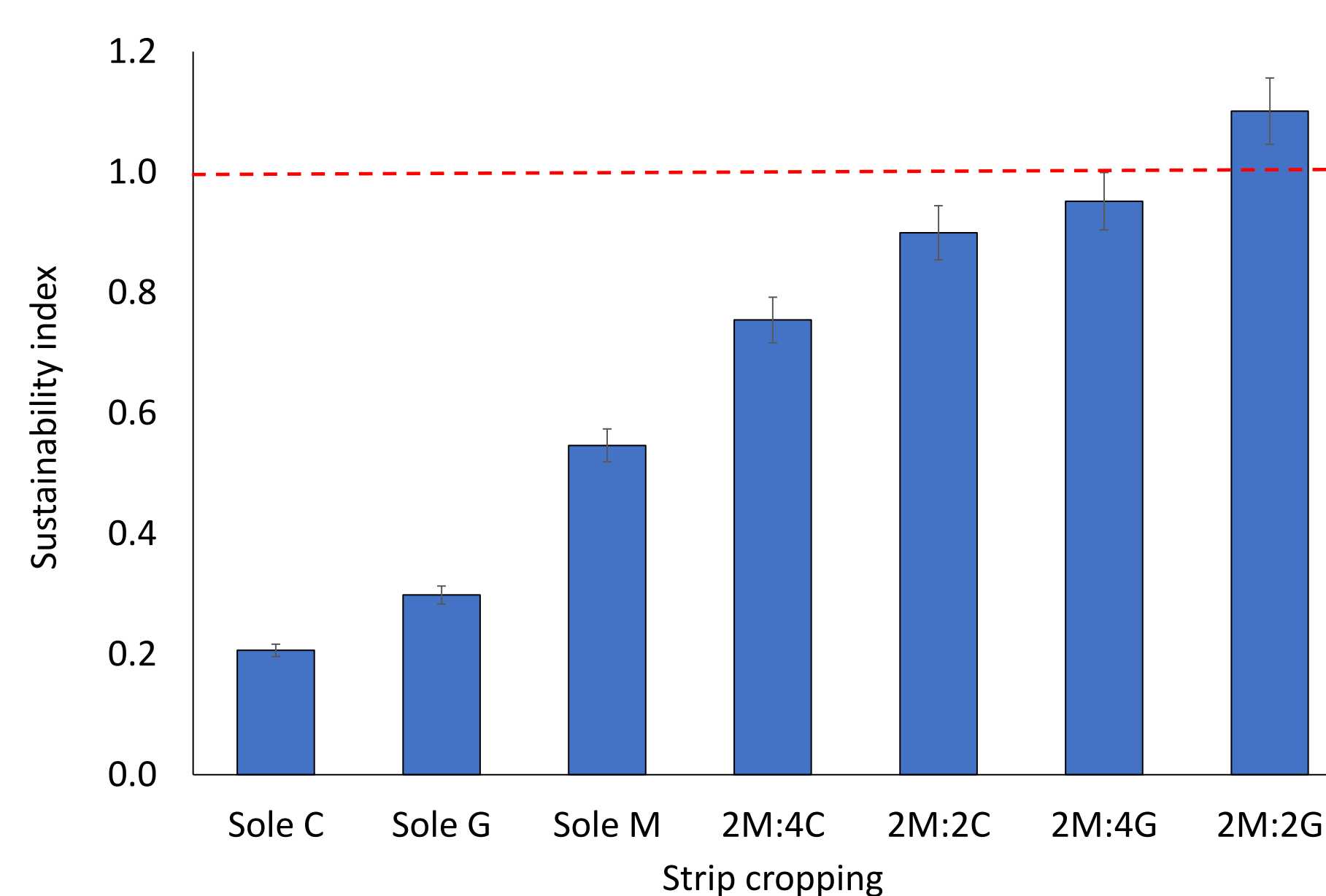


Figure 4. Sustainability index as affected by maize-legume strip cropping. Broken red line (--) indicates sustainability threshold and bars represent standard error

## Conclusion

Strip cropping 2M:2G option can enhance the sustainability of smallholder farming systems in northern Ghana and similar agro-ecologies in West Africa and better farmers wellbeing through its positive effects on income, nutrition, environment and gender equity.

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## Partners

