Economic benefits and costs of nature-based solutions in low- and middle-income countries

Peter Steward, Namita Joshi, Gabrielle Kacha, Babra Ombewa, Elijah Mumo, Lolita Muller, Brayden Youngberg, Nick Magnan, Todd Rosenstock

Suggested citation: Steward P, Joshi N, Kacha G, Ombewa B, Mumo E, Muller L, Youngberg B, Magnan N, and Rosensotck T. 2023. Economic benefits and costs of nature-based solutions in low- and middle-income countries. Working Paper. Alliance of Bioversity-CIAT. Rome.

Table of Contents

Summary

Agriculture's intersection with environmental sustainability necessitates a transition more environmentally friendly farming solutions such as Nature-based solutions. Whereas the environmental benefits for soil, air, and water are documented, the private benefits for farmers are less so, especially in low- and middle-income countries. We conducted a rapid assessment of economic implications of adopting NbS. Central to our research approach is the emphasis on profit, moving away from the often-cited gross revenue metrics. Profit, which factors in the costs, gives us an unfiltered view of the farmer's genuine earnings, thereby offering a more realistic understanding of the financial dynamics of NbS. Our analysis, informed by 181 studies, stands out for its in-depth exploration of the economic implications of different agricultural NbS. Unlike many prior investigations, this analysis dives beyond mere gross revenue figures to provide a clearer picture of the actual economic outcomes. Our findings reveal that while NbS can lead to an upswing in gross revenue, this doesn't automatically translate to heightened profitability. Notably, environmentally commendable practices like reduced fertilizer use may not yield immediate financial dividends. Farmers embarking on these practices often face a transition period, necessitating adaptation to new agricultural dynamics. Additionally, practices such as reduced tillage show promising economic outcomes, while others, like biochar introduction, demand considerable initial financial outlays. Furthermore, our analysis found little evidence supporting the prevailing assumption that bundling multiple NbS yields compounded benefits. The insights from our study have significant ramifications for policy design. It's crucial for policymakers to differentiate between mere revenue and tangible profit to accurately gauge the economic realities confronting farmers. The initial challenges and costs associated with transitioning to NbS underscore the need for robust support mechanisms, including subsidies and educational initiatives. Moreover, interventions need to be finely tuned, especially for smallholder farmers in low-to-middle-income regions, to accommodate the unique financial challenges they face. To catalyze widespread adoption of NbS, education about their long-term benefits and the establishment of financial infrastructures are paramount. It is clear that the economic intricacies of NbS are multifaceted, the right blend of policies and unwavering commitment can enable a symbiotic relationship between environmental sustainability and economic prosperity in agriculture.

Introduction

Our planet's health and the prosperity of human communities are intricately linked with the vitality of our agricultural systems(1). They maintain food security, economic stability, and the health of natural resources(2). Agriculture development has been a boon for society(3), with estimates suggesting recrent intensification supports for more than 2 billion additional people being alive today(4). However, it is becoming increasingly evident that agriculture, reduces biodiversity, worsens water quality, and contributes to climate change, amongst other environmental concerns(5). Furthermore, current agricultural practice may not be ideal under a future climate conditions(6,7). Realization of the negative externalities of intensification and the risks to future agricultural productivity suggests the need for a shift towards environmentally friendly and resilient farming systems, offering an alternative agricultural development trajectory(8).

Nature-based solutions (NbS) protect, sustainably manage, and restore ecosystems in ways that simultaneously improve human well-being, mitigate climate change, and support biodiversity (9) and therefore offer an opportunity to meet the dual objectives of high agricultural productivity and environmental conservation(10). These solutions often focus on natural systems such as forests, wetlands, and mangroves, harnessing existing ecological processes and functions to enhance environmental outcomes. But they are also relevant to agriculture. In the agricultural context, NbS take various forms - from agroforestry and cover cropping to sustainable land and water management practices(11), with NbS being proposed for many different production contexts.

Several reports indicate agricultural NbS can be effective, establishing the technical potential of NbS to meet productivity and environmental goals (Table 1). In many contexts, these practices have also been shown to increase resistance to climate change and variability(12,13). This suggests NbS may confer benefits to both the environment and the individual farmer. Instead of relitigating environmental discussions (14–17), this report by contrast examines the economic impact of implementing agricultural NbS, a crucial but under-explored facet of sustainable development discourse(10). We specifically investigate what the literature says about whether NbS can deliver economic advantages for producers. In other words, does the existing evidence demonstrate that NbS makes economic sense for the farmers?

Table 1 | Qualitative impact of exemplar agricultural nature-based solutions on productivity and the environment in comparison to current common practice. Evaluation based on existing meta-analyses and syntheses where available. + = increase, +/- = mixed results or uncertain, - = decrease.

Solution	Yield	Climate	Biodiversity	Select sources
Agroforestry	+/-	+	+	(18–20)
Crop diversification	+	+	+	(21,22)
Reduced tillage	-	+/-	+	(23–25)
Organic fertilizer	+	+	+	(26)
Cover crops	+	+/-	+	(27,28)

There are many economic implications of adopting NbS in agriculture to understand. Of paramount importance is gaining a clear comprehension of the direct, private benefits and costs to farmers. While society as a whole enjoys the environmental benefits of NBb, farmers bear the cost of implementation, which can be large and immediate. If the farmer benefits of adopting NBS, whether they are improvements in yield, reductions in input costs, enhanced resilience to climate volatility, or better access to new markets and payments for ecosystem services, do not exceed costs, adoption will not be attractive from the farmer's perspective. As such, any exploration of the economics of NbS must begin with a thorough analysis of these private benefits, as well as costs. Ensuring farmers find enough value in these practices to adopt them is a prerequisite for broader societal and environmental gains. This report will therefore center on elucidating these benefits, laying the groundwork for strategies that make economic sense to those on the frontlines of our agricultural systems.

The economics of NbS are especially complex for smallholder farmers in low- and middle-income countries. In this context, farmers often experience different yields than those measured on experiment stations(29,30). These farmers also face a variety of market failures such as poor land tenure and lack of access to markets(31,32). These market failures can be idiosyncratic, making the costs and benefits of adopting a given NBS vary from farmer to farmer. For example, a farmer with weak land tenure may heavily discount the future benefits of improvements in soil health, whereas a farmer with strong land tenure will not. Some farmers may have access to markets in which to sell a new type of crop, whereas others do not (Ashraf et al., 2009). A farmer who lacks access to finance bears an extra cost of making any capital investment in agriculture because of other needs for scarce cash (food, children's education, medical expenses), whereas a farmer who has access to finance is better positioned to invest (Magruder, 2018). One farmer may have surplus family labor available for agriculture, whereas another does not (White et al., 2005). Some farmers may need to diversify to manage uninsured risk, or to ensure consumption needs (Michler and Josephson, 2017). This can make it more costly to adopt new technologies or practices that are only used in one type of production (Nerlove et al. 1996). All these potential dimensions of variability make it difficult to accurately measure the private benefits and cost of adoption in developing countries

Future analysis on the economics NbS, particularly in low- and middle-income should investigate additional economic questions. For example, it is critical to evaluate the short-term costs associated with transitioning from conventional practices to NbS against the potential for long-term benefits. Understanding how farmers discount future income streams, as well as how liquidity constraints can impede otherwise beneficial investments, are essential to understanding adoption decisions. We also need to know more about who reaps the benefits of the transition to NbS and when. This will help policy makers devise mechanisms for the equitable distribution of these benefits. We need to understand how the changing market environments (e.g., food demand, input supply) might encourage or impede the adoption of such solutions. While important, these questions are outside the scope of the current report.

This report aims to bridge knowledge gaps and provide clear, actionable insights for policymakers, practitioners, and stakeholders based on a compilation and synthesis of the available data. It seeks to underscore the urgent need for integrating NbS into agricultural

economics and policy, underlining its value as an effective strategy for sustainable agricultural development in an increasingly resource-constrained and climate-altered world.

Methods

This investigation conducted a systematic review and meta-analysis of scientific literature, focusing on the economics of NbS in the agricultural sector. Meta-analysis is a research technique used to combine data from multiple studies, each examining the effect of a common intervention on a particular set of outcomes. By aggregating data from studies that utilize different samples, researchers can derive a more comprehensive and generalizable understanding of the likely impacts of an intervention. This approach is considered the 'gold standard' in many disciplines for drawing policy-relevant conclusions from extensive bodies of literature, making it a valuable tool for policy development and assessment. Despite its strengths, meta-analysis is not without limitations, such as publication bias, where studies demonstrating significant impacts are more likely to be published than those that do not find such effects. Nonetheless, the utility of meta-analysis in synthesizing research and contributing to evidence-based policymaking is widely acknowledged. We adopted a rigorous, replicable, and structured approach, consistent with best practice(33,34).

Literature search and screening

Following this identification, we crafted a set of precise keywords related to these NbS, thereby facilitating a comprehensive search (Table S2). Utilizing Web of Science, a leading academic database, we searched the literature. We evaluated titles and abstracts from this search against pre-defined criteria including: (1) Does the study report a field study (modelling studies were not included) (2) Does the study report data on at least one of the ten NbS of interest and a non-NbS control, (3) Does the study include data on at least one economic indicator of interest (see below), and (4) Did the study take place in a low- or middle-income country. To prioritize and screen titles and abstracts R package BaysREN and the Colandr application. These tools filtered the studies to include the most pertinent, based on predefined criteria. Prioritization used machine learning BART (Bayesian Additive Regression Tree) algorithms that were trained on a hand-curated corpus of articles. BART assigns a probability of inclusion to articles which was used to order title and abstract screening. The ordered list of articles was screened until less than 5% of articles were being retained. Articles that passed abstract and screening were then downloaded for full text screening and data extraction

Nature-based solutions of interest

The assessment of agricultural NbS started with the identification of the ten most significant NbS through an exhaustive review of foundational documents pertinent to this field. This review established the target set of potential opportunities to guide our inquiry (Table 2).

Table 2 | The agricultural nature-based solutions included in this analysis.

Solution	Relationship to biodiversity and climate change mitigation
Agroforestry	Accumulates carbon in biomass and soils and provides habitat for biodiversity
Biochar	Converts organic matter into stable carbon and can reduce nitrous oxide and methane fluxes under some conditions
Cover crops	Improves soil quality and function, erosion reduction, reduced use of inorganic inputs
Intercropping	Increase biodiversity, reduce use of inorganic inputs in some conditions
IPM	Reduces use of harmful agrochemical
Organic fertilizer	Increase soil organic matter, reduces use of inorganic inputs
Reduced erosion	Conserves soil health
Reduced fertilizer use	Reduces greenhouse gas emissions and climate impact of agriculture
Reduced irrigation	Reduced demand for water
Residue/mulch	Conserves soil moisture and helps to accumulate carbon in soils
Rotation	Improves soil quality and function, increases biodiversity

Outcomes of interest

Our outcomes of interest are gross revenue, costs, and profit (all in per hectare terms). These outcomes are highly relevant to the farmer and widely calculated in the literature. Costs reported in the literature are typically limited to variable costs, or costs that vary with the quantity produced per unit area. A minority of studies report total costs, which in this case are variable costs plus the rental cost of land. Because our outcomes are all reported log likelihood ratios (log-RRs), they consider this cost for both NbS and control plots, and thus mostly cancel each other out. There were too few studies with total costs to treat this as a separate metric.

We also report the benefit cost ratio (BCR), which is gross revenue over costs. Benefit cost ratios have the advantage of always being positive, meaning it is always possible to calculate log-RRs. In instances where profits from either the NbS method or its relevant control are negative, log-RR cannot be calculated. However, cost-benefit ratios may not be very relevant to farmers. A high-cost NbS may be more profitable than its low-cost conventional alternative yet have a lower benefit-cost ratio. For example, suppose implementing an NbS costs $50 per hectare and yields $400 in revenue. The conventional alternative costs $10 per hectare and yields $100 in revenue. The NbS results in $350 in additional profit and has a BCR of 8. The conventional alternative results in only $90 in profit but has a BCR of 10. BCRs are useful to analyze the cost-effectiveness of interventions that are highly scalable. At a landscape level, this may be true for agricultural investments like NbS. With $100 one could plant either two hectares using the NbS and generate $800 in revenue or plant 10 hectares using the conventional method and generate $1000 in revenue. Under these circumstances, the conventional method is the better choice. For an individual farmer with only one hectare of land, however, the NbS is the better choice.

Data extraction

We carried out data extraction using a combination of manual and automated methods. Information about the study, including its geographic location, interventions, and economic

indicators, was extracted from each paper. To speed up the organization of the collected literature, we incorporated ChatGPT, OpenAI's language model. This tool helped us to identify and tag keywords in titles and abstracts that were directly related to the identified NbS, economic indicators, and locations in low- and middle-income countries. When necessary, the results from ChatGPT were manually harmonized. Researchers with experience in agriculture and data synthesis manually extracted intervention and economic data.

Data analysis

The process of analysis adheres to conventional meta-analytical procedures, widely recognized in medicine, ecology, and various other fields(34). These analyses were undertaken using R4.2.1 (R Core Development Team 2021). We used a simple linear mixed-effects model with specific weighting (Pittlekow et al., 2014).

$$w = \left(\frac{n_1 n_2}{n_1 + n_2}\right)/S$$

where n is sample size of groups 1 and 2 and S is the number of observations contributed to the dataset by the study to which the groups belong. Restricted Maximum-Likelihood (REML) was used for estimating effect sizes as it's more efficient and less biased (Viechtbauer, 2005). Parametric bootstrapping is used to construct confidence intervals computed from the bootstrap distribution confint.merMod function of the lme4 package, v 1.1-30, Bates *et al.,* 2015). All reported outcomes are response ratios, or log ratio of the NbS value and the value for the relevant non-NbS control, as is common for ecological meta-analysis (Lajeunesse, 2011). This is the proportionate change in an outcome relative to the control, where increases are positive values and decreases are negative values. The log-RR can be converted to an approximate percentage change as $\%\Delta = \exp(\log R\, R) - 1$.

When calculating ratios if one of the numerator and denominator is positive and the other negative the response ratio becomes negative and the result is meaningless, as such these observations were removed from the dataset. We allowed up to 7.5% of observations within an analysis group to be excluded due to a negative response ratio, if this threshold was exceeded the group was excluded from analysis altogether.

Results

Dataset

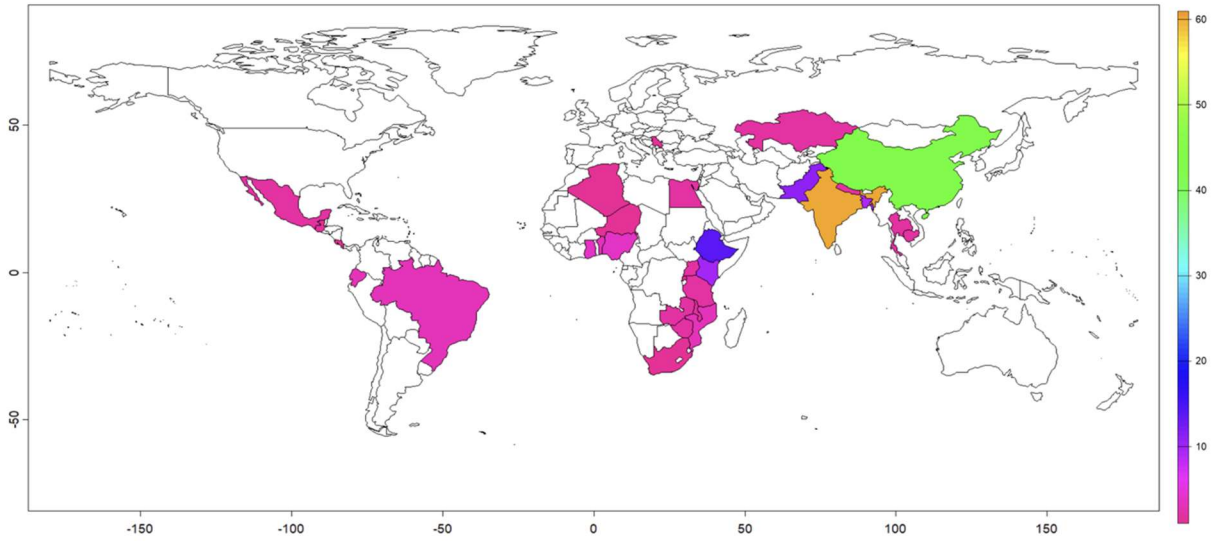
Our search led to the discovery of 10,833 articles concerning the twelve recognized agricultural NbS. Nine hundred ninety-five articles (995, 9.1%) fulfilled our specific requirements for a detailed review. Among these, 198 articles provided clear data on gross revenue and profit, which are the main economic factors we were investigating, which is 1.8% of the original search and approximately the expected inclusion rate based on previous agricultural assessments(35).

We extracted data from 198 articles (Table S3). The resulting dataset includes 6463 observations of economic outputs from 12 NbS. Deriving additional indicators from data provided in the papers

(e.g., BCR) increased the size of the final dataset to 9705 observations. This collection of data, possibly the most extensive dataset on field-level economic budgets currently available(36), forms the foundation for our meta-analysis.

The final dataset (Table S4) includes studies from 30 different countries, as shown in Figure 1. The data spans the Global South, including several countries with a high number of observations. Specifically, India had 2,221 observations from 61 studies, China had 1,096 from 44 studies, Ethiopia had 771 from 10 studies, Pakistan had 463 from 11 studies, Kenya had 319 from 10 studies, Bangladesh had 399 from 8 studies, and Ghana had 248 from six studies. Despite this wide geographic coverage, there are still significant gaps in understanding of major regions.

Figure 1 | Geographic distribution and number of studies by countries (see Table S1 for more details)



Economic impacts

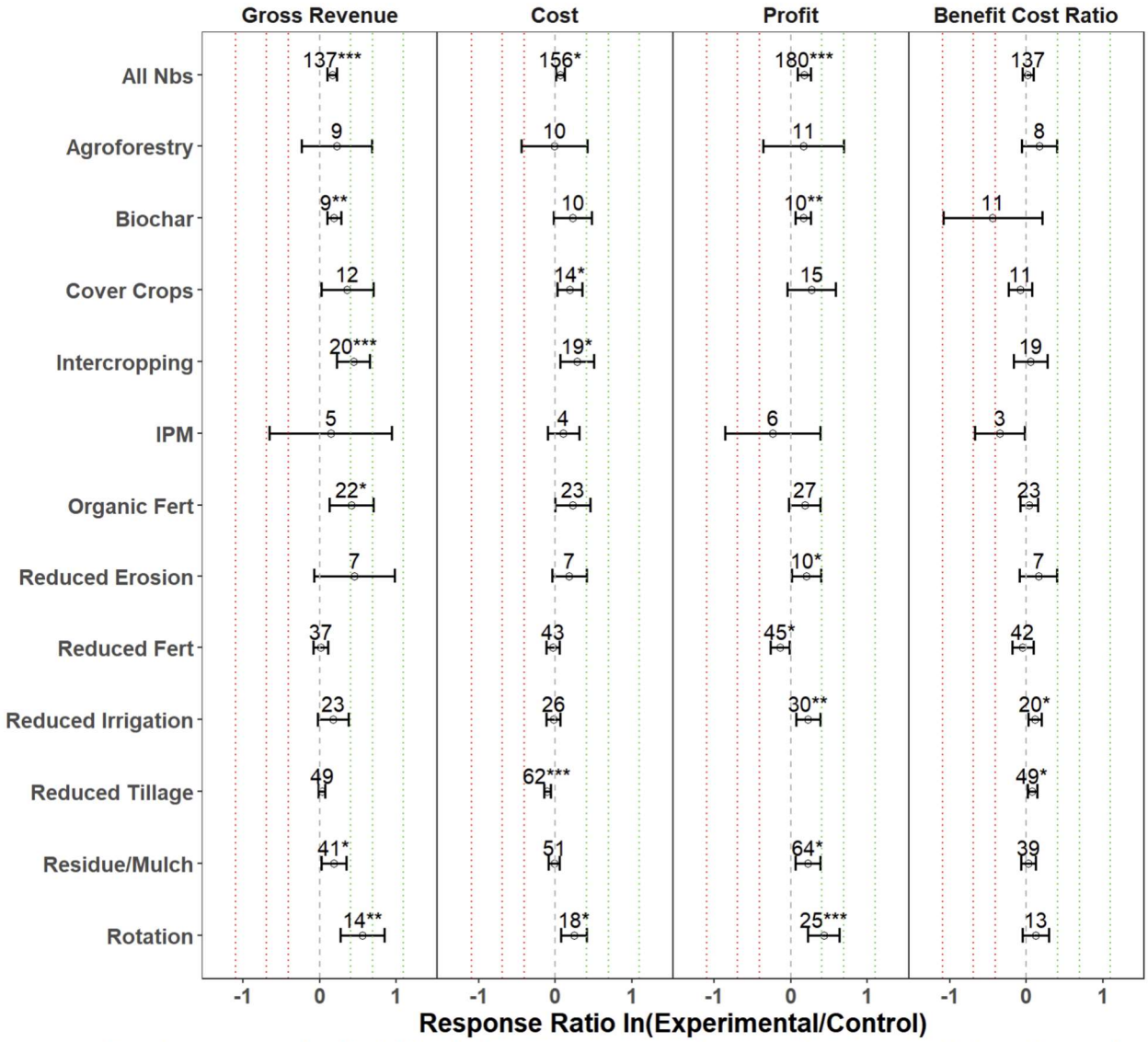
The log-RRs for the economic outcomes of interest are shown in Figure 1 and Tables 3 and 4. We examine the impacts of Nature-based Solutions (NbS) in two distinct ways: 1) the aggregate result of any observations containing a core NbS practice (i.e. the average of any observations implementing the NbS alone and in combination with other practices), and 2) the results of specific combinations of NbS. The aggregated analysis of a core NbS across any combinations of practices that include it, as per Figure 1 and Table 3, aligns with how policymakers and investors typically discuss NbS. However, NbS are often recommend to be adopted in bundles, and the results for some of these bundles are showin in Table 4. Consider conservation Agriculture (CA) which combines reduced tillage, mulching and crop rotation. In approach 1 the NbS of CA would be analyzed separately, for example a reduced tillage dataset would contain all CA observations (as these contain reduced tillage) and any other observations containing reduce tillage, crop rotation and intercropping are treated the same. In approach 2 CA is analyzed as

"reduced tillage + crop rotation + mulch" and only observations that contain these practices contribute to the analysis dataset. When reduced tillage is analyzed using approach 2 the dataset contains observations with reduced tillage only.

By presenting both aggregated and disaggregated results, we offer a comprehensive view for stakeholders' interests.

NbS Overall (Aggregated)

When all NbS in this analysis are considered collectively, the log-RR for gross revenue is 0.16 (a 17.5% increase over the control), the log-RR for costs is 0.06 (a 6.1% increase), and the log-RR for profit is 17.5 (a 19% increase). These increases were all statistically significant to the 10% confidence level (1% for gross revenue and profits). The log-RR for the BCR is 0.017, or a 1.7% increase that is not statistically significant. As stated earlier, BCRs may not be a good indicator of the attractiveness of a technology to a farmer. Overall, NbS offer substantially higher profits to farmers while not exhibiting higher BCRs.



Dotted lines correspond to 50%, 100% and 200% increase or decrease. Numbers indicate number of studies contributing data.

Figure 1 | The economics of agricultural NbS calculated aggregated across all observations containing the focal NbS (rows). Benefit cost ratio are gross revenue divided by costs. All units are log-RRs with vertical bars marking percent differences for the NbS relative to its relevant control. Values are reported in Table 3.

Agroforestry

The database includes 12 agroforestry studies. The log-RR for gross revenue is 0.22 (a 25% increase over the control) and the log-RR for cost was –0.013 (a decrease of 1.4%). The log-RR for profit is 0.16 (a 17.8% increase). Here we find a similar increase (18.5%) in the BCR due to the low costs of agroforestry. Because of the small sample of studies, none of these differences were statistically significant at the 10% confidence level.

Biochar

Based on ten studies, the log-RR for gross revenue is 0.19, or a 20.8% increase relative to the control, and the log-RR for costs is 0.23, or a 25.4% increase. The log-RR for profit is 16.2, a 17.6% increase. The estimates for revenue and profit are significant at the 5% confidence level whereas the estimate for cost approaches significance at the 10% level. While it may seem counterintuitive that profits increase even though the percent increase in cost exceeds the percent increase in gross revenue, it is possible when the cost of production under the control is low relative to gross revenue. The BCR for biochar is 35% lower than for the control, although the estimate is very noisy. Again, it is possible that a technology that presents higher per-acre profits can have a lower BCR than the alternative, particularly when the alternative is very low cost as is the case here.

Cover crops

Based on 15 studies, the log-RR of for gross revenue for cover crops is 0.36, or a 43.5% increase. The increase in cost is also high, with a log-RR of 0.19 or 20.4%. The resulting log-RR for profit is 0.27, or a 30.5% increase. The increase for revenue approaches statistical significance at the 10% confidence level whereas the increase for cost is significant at the 10% confidence level. As is often the case with high-cost/high-returns technologies, the BCR for cover crops is 7.8% lower (not statistically significant) than the control despite the technology practice being highly profitable.

Intercropping

Based on 13 studies, the log-RR of gross revenue for intercropping is 0.44, or a 55% increase. The log-RR for cost is 0.28, or a 32.7% increase. These increases are significant at the 5% and 10% confidence levels, respectively. Because several studies reported negative profit for either the treatment or the control, we could not calculate the log-RR for profit. We see a small (5.5%) but insignificant increase in the BCR.

Integrated Pest Management

IPM is one of two NbS in this study that exhibits a decrease in profitability (-21.2%), albeit a statistically insignificant one. The log-RR for gross revenue is 0.145, or an increase of 15.6%, and the log-RR for costs is 0.11, or an increase of 11.3%. Neither of these differences are statistically significant. We find that the BCR decreases by 29.5% with IPM, a decrease that approaches statistical significance at the 10% confidence level. These findings are based on only six studies, a relatively small sample.

Organic fertilizer

Thirty-one studies in our dataset consider organic fertilizer. The log-RR for gross revenue is 0.42, or an increase of 51.4% that is significant at the 10% confidence level. The log-RR for cost is 0.22, or an increase of 25.2%, leaving an increase in profit of 19.7% and an increase in BCR of 3.7%. These increases are significant at the 10% confidence level.

Reduced erosion

Eleven studies in our dataset consider reduced erosion. The log-RR for gross revenue is 0.45, or a 57% increase compared to the control. The log-RR for cost is 0.18, or a 20% increase. These estimates approach significance at the 10% level. The log-RR for profit is 0.18, or a 19.7% increase that is significant at the 10% confidence level. The BCR increases by 17%, approaching significance at the 10% confidence level.

Reduced fertilizer

Reduced fertilizer, considered in 53 studies, is the other NbS in our dataset that exhibits negative profits. The log-RR for gross revenue is 0.01, or a 1% increase, and the log-RR for costs is –0.03, or a 3% decrease. Neither change is statistically significant. Perhaps surprisingly, the log-RR for profit is –0.14, equivalent to a 13% decrease that is significant at the 0.1 confidence level. The difference in BCR is also negative but not significant. The apparent discord between the difference in gross benefit being positive, the difference in cost being negative, and the difference in profit being negative is likely due to the eight studies that present profit data without presenting gross revenue data.

Reduced irrigation

Our dataset includes 30 studies on reduced irrigation. The log-RR for gross revenue is 0.17, a 19.1% increase. The log-RR for cost is –0.02, a 2.4% decrease. Neither is statistically significant at conventional levels. The log-RR for profit is 0.22, or a 25% increase that is significant at the 5% confidence level. The CBR also increases by 11.9%, significant at the 10% confidence level.

Reduced tillage

Our dataset contains 67 studies on reduced tillage. The log-RR for gross revenue is 0.03, or a 3% increase (not significant). The log-RR for cost is 0.104, or a decrease of 10% that is significant at the 1% confidence level. Because many studies contained negative values for profit under either NbS or the corresponding control, we could not calculate log-RR. However, we do find a log-RR of 0.076 for the BCR, an increase of 8& significant at the 10% confidence level.

Residue/mulch

Sixty-four studies in our dataset consider residue or mulch use. The log-RR for gross revenue is 0.185, or an increase of 20.3% that is significant at the 10% confidence level. There is a small (1%) and insignificant decrease in cost. The log-RR for profit is 0.22, or a 24.8% increase that is significant at the 10% confidence level. The BCR increases by 2.8% with residue/mulch, although not significantly.

Crop rotation

Twenty-seven studies consider crop rotation, although many only report profits. The log-RR for gross revenue is 0.55, or an increase of 74% that is significant at the 5% confidence level. There is

also a substantial increase in cost. The log-RR is 24.4, or an increase of 27.7% significant at the 10% confidence interval. These results are based on 14 and 18 studies respectively. The full set of 25 studies yields a log-RR for profit of 0.22, or an increase of 24.8%. The increase in BCR, based on 13 studies, is 2.8% and not significant at conventional levels.

Table 3 | Impact of bundled NbS on costs, gross revenue, profit, and benefit cost ratios for practices applied alone or together in bundles of multiple practices.

							95% CIs		
Practice	Outcome	Obs	Studies	Sites	RR	Perc	Low	High	Sig
All NbS	BCR	1836	137	152	0.019	1.92	-4.4	9.71	0.587
All NbS	Cost	1566	156	164	0.062	6.4	1.19	13.19	0.033*
All NbS	Gross Revenue	1431	137	145	0.162	17.59	11.35	26.82	<0.001***
All NbS	Profit	2040	180	208	0.176	19.24	11.32	31.91	<0.001***
Agroforestry	BCR	89	8	8	0.17	18.53	-5.41	50.21	0.192
Agroforestry	Cost	54	10	10	-0.014	-1.39	-29.06	68.32	0.952
Agroforestry	Gross Revenue	45	9	9	0.223	24.98	-9.91	125.49	0.365
Agroforestry	Profit	51	11	11	0.164	17.82	-18.61	132.93	0.553
Biochar	BCR	189	11	13	-0.442	-35.73	-66.2	23.54	0.206
Biochar	Cost	117	10	12	0.227	25.48	-1.57	61.5	0.1
Biochar	Gross Revenue	106	9	11	0.189	20.8	10.75	32.81	0.002**
Biochar	Profit	130	10	12	0.162	17.59	7.1	30.37	0.007**
Cover Crops	BCR	38	11	12	-0.081	-7.78	-20.39	7.53	0.313
Cover Crops	Cost	59	14	15	0.186	20.44	4.24	44.25	0.042*
Cover Crops	Gross Revenue	49	12	13	0.362	43.62	10.8	119.7	0.058
Cover Crops	Profit	61	15	16	0.266	30.47	1.36	90.74	0.12
Intercropping	BCR	171	19	19	0.054	5.55	-14.51	32.1	0.633
Intercropping	Cost	138	19	19	0.283	32.71	6.43	66.26	0.023*
Intercropping	Gross Revenue	136	20	21	0.441	55.43	26.19	94.48	0.001***
IPM	BCR	17	3	4	-0.349	-29.46	-48.96	-1.67	0.136
IPM	Cost	15	4	5	0.107	11.29	-9.24	37.96	0.373
IPM	Gross Revenue	16	5	6	0.145	15.6	-47.69	158.75	0.737
IPM	Profit	24	6	7	-0.239	-21.26	-54.62	57.87	0.482
Organic Fert	BCR	243	23	27	0.036	3.67	-7.28	16.97	0.545
Organic Fert	Cost	169	23	24	0.224	25.11	-0.21	57.86	0.067
Organic Fert	Gross Revenue	176	22	23	0.415	51.44	13.6	103.47	0.011*
Organic Fert	Profit	239	27	38	0.18	19.72	0.1	51.18	0.095
Reduced Erosion	BCR	41	7	10	0.158	17.12	-6.78	52.22	0.241
Reduced Erosion	Cost	30	7	7	0.183	20.08	-3.16	51.95	0.165
Reduced Erosion	Gross Revenue	25	7	7	0.453	57.3	-6.41	168.77	0.143
Reduced Erosion	Profit	54	10	15	0.207	23	5.49	54.7	0.049*
Reduced Fert	BCR	498	42	53	-0.049	-4.78	-16.01	10.59	0.49
Reduced Fert	Cost	426	43	50	-0.031	-3.05	-10.55	5.44	0.461
Reduced Fert	Gross Revenue	400	37	44	0.011	1.11	-7.7	12.09	0.823

							95% CIs		
Practice	Outcome	Obs	Studies	Sites	RR	Perc	Low	High	Sig
Reduced Fert	Profit	543	45	57	-0.141	-13.15	-22.17	-0.96	0.025*
Reduced Irrigation	BCR	213	20	24	0.112	11.85	2.64	22.8	0.022*
Reduced Irrigation	Cost	209	26	30	-0.024	-2.37	-8.69	9.32	0.604
Reduced Irrigation	Gross Revenue	166	23	27	0.174	19.01	0.13	50.6	0.105
Reduced Irrigation	Profit	236	30	36	0.224	25.11	10.96	52.54	0.009**
Reduced Tillage	BCR	507	49	55	0.076	7.9	1.52	15.55	0.025*
Reduced Tillage	Cost	453	62	69	-0.104	-9.88	-13.51	-5.64	<0.001***
Reduced Tillage	Gross Revenue	394	49	55	0.03	3.05	-1.06	8.26	0.204
Residue/Mulch	BCR	375	39	38	0.028	2.84	-6.21	13.8	0.578
Residue/Mulch	Cost	336	51	51	-0.017	-1.69	-8.04	5.83	0.643
Residue/Mulch	Gross Revenue	281	41	40	0.185	20.32	3.65	42.32	0.028*
Residue/Mulch	Profit	532	64	69	0.222	24.86	8.06	50.19	0.01*
Rotation	BCR	42	13	13	0.123	13.09	-4.28	35.35	0.191
Rotation	Cost	69	18	18	0.244	27.63	8.45	51.83	0.011*
Rotation	Gross Revenue	36	14	14	0.556	74.37	32.04	134.41	0.002**
Rotation	Profit	112	25	26	0.429	53.57	36.56	105.93	<0.001***

NbS Disaggregated

NbS are often implemented in specific bundles, and there are many possible sets of practices. We identified the most common bundles in the literature for which there are economic analyses for this meta-analysis. Using the same techniques, we estimate gross revenue, cost, profit, and BCR (Table 4, Figure S1). In most cases there are very few studies that consider a given bundle, so the sample sizes are small and the estimates imprecise.

Intercropping + rotation

There are four studies in our database that consider intercropping and crop rotation as a bundle. The log-RR for gross revenue is 0.65, or an increase of 91.5%, that is significant at the 5% confidence level. The log-RR for cost is 0.23, or an increase of 25.9%. The log-RR for profit is 0.42, or an increase of 52.3%. While large, the increases for cost and profit are not significant at conventional levels. The increase in BCR of 13.4%, however, is significant at the 10% confidence level.

Reduced fertilizer + residue/mulch

There are only three studies that consider a bundle of reduced fertilizer and residue/mulch. The log-RR for gross revenue is –0.09, or a decrease of 8.7%. The log-RR for cost is –0.10, or a decrease of 9.6%. Neither difference is statistically significant at conventional levels. We could not calculate the log-RR for profit because of negative values, but we do find a log-RR of 0.02 for the BCR, or a statistically insignificant 2% increase.

Reduced irrigation + reduce tillage

Fourteen studies consider a combination of reduced irrigation and reduced tillage. The log-RR for gross revenue is 0.01, or a statistically insignificant 1.6% increase. This bundle is primarily cost-reducing, and the log-RR for cost is –0.12, or a 12% decrease that is significant at the 1% confidence level. The log-RR for profit is 0.11, or an 11.8% increase that is significant at the 10% confidence level. The BCR increases by 14.6%, which is significant at the 5% confidence level.

Reduced fertilizer + organic fertilizer

Reducing inorganic and/or synthetic fertilizer and adopting organic fertilizer can be considered an NbS bundle. There are 10 instances of this bundle in our dataset. We find a log-RR for gross revenue of 0.109, or an increase of 11.6%, significant at the 10% confidence level. Cost also increases with this bundle. The log-RR is 0.079, or an 8.3% increase (not significant). The log-RR of profit is very noisy, but the point estimate is –0.12, or a decrease of 11.9%. The change in the BCR is close to zero and not significant.

Reduced tillage + residue/mulch

There are 27 studies in our database with a bundle of reduced tillage with residue/mulch, as these NbS are commonly combined in practice. The log-RR for gross revenue is 0.057, or an increase of 5.9%, that is not statistically significant. The bundle yields a log-RR for cost of –0.14, or a decrease of 13.6% that is significant at the 10% confidence level. Together these yield a log-RR of 0.21 for profit, or a 23.5% increase. This estimate, however, is very noisy and not significant at conventional levels. There is no difference in BCR between this bundle and the control.

Reduced irrigation + reduced tillage + residue/mulch

The one bundle of three NbS considered by multiple studies is reduced irrigation with reduced tillage and residue/mulch. There are five such studies. There is no change in revenue but a 13.6% decrease in cost (the log-RR is –14.6). We find a log-RR of 0.21, or a 23.4% increase in profit, but this increase is not significant. Similarly, we find a 24.8% increase in BCR that is also not significant.

.

Table 4 | Impact of bundled NbS on costs, gross revenue, profit, and benefit cost ratios for solo or bundles of multiple practices. Also Figure S1

							95% CIs		
Practice	Outcome	Obs	Studies	Sites	RR	Perc	Low	High	Sig
Biochar+Reduced Fert	BCR	45	4	6	-1.180	-69.27	-77.9	-32.1	0**
Biochar+Reduced Fert	Cost	19	3	5	-0.267	-23.43	-34.7	-7.5	0.005**
Biochar+Reduced Fert	Profit	19	3	5	0.105	11.07	6.0	16.7	0**
Intercropping+Rotation	BCR	12	3	3	0.126	13.43	3.5	25.7	0.016*
Intercropping+Rotation	Cost	8	4	4	0.230	25.86	-7.5	147.7	0.305
Intercropping+Rotation	Gross Revenue	7	3	3	0.650	91.55	44.1	186.3	0.004**
Intercropping+Rotation	Profit	9	4	4	0.421	52.35	11.7	252.5	0.13
Reduced Fert+Organic Fert	BCR	51	8	8	0.042	4.29	-11.2	23.6	0.633
Reduced Fert+Organic Fert	Cost	39	10	10	0.080	8.33	-3.4	23.3	0.232
Reduced Fert+Organic Fert	Gross Revenue	41	8	8	0.109	11.52	3.3	20.7	0.029*
Reduced Fert+Organic Fert	Profit	52	9	12	-0.126	-11.84	-33.3	28.6	0.466
Reduced Fert+Residue/Mulch	BCR	24	3	3	0.020	2.02	-22.8	36.0	0.901
Reduced Fert+Residue/Mulch	Cost	16	3	3	-0.101	-9.61	-13.3	-5.5	0.14
Reduced Fert+Residue/Mulch	Gross Revenue	16	3	3	-0.091	-8.7	-30.0	21.6	0.579
Reduced Irrigation	BCR	94	13	16	0.025	2.53	-4.3	10.2	0.488
Reduced Irrigation	Cost	95	17	20	0.006	0.6	-6.7	8.4	0.887
Reduced Irrigation	Gross Revenue	91	15	18	0.029	2.94	-4.2	11.0	0.452
Reduced Irrigation	Profit	105	19	22	0.114	12.08	1.0	27.0	0.064
Reduced Irrigation+Reduced Tillage	BCR	90	10	13	0.135	14.45	7.6	23.1	0.002**
Reduced Irrigation+Reduced Tillage	Cost	61	13	16	-0.129	-12.1	-16.7	-4.5	0**
Reduced Irrigation+Reduced Tillage	Gross Revenue	55	10	13	0.016	1.61	-2.5	6.4	0.471
Reduced Irrigation+Reduced Tillage	Profit	65	14	17	0.111	11.74	2.6	23.1	0.029*
Reduced Irrigation+Reduced Tillage+Residue/Mulch	BCR	25	3	3	0.222	24.86	-8.6	79.4	0.325
Reduced Irrigation+Reduced Tillage+Residue/Mulch	Cost	19	5	5	-0.235	-20.94	-33.8	0.9	0.084
Reduced Irrigation+Reduced Tillage+Residue/Mulch	Gross Revenue	15	3	3	0.007	0.7	-12.1	17.2	0.935
Reduced Irrigation+Reduced Tillage+Residue/Mulch	Profit	19	5	5	0.091	9.53	-8.2	48.6	0.469
Reduced Tillage+Residue/Mulch	BCR	64	16	17	-0.010	-1	-17.3	19.5	0.916

							95% CIs		
Practice	Outcome	Obs	Studies	Sites	RR	Perc	Low	High	Sig
Reduced Tillage+Residue/Mulch	Cost	64	22	24	-0.147	-13.67	-23.5	-2.5	0.027*
Reduced Tillage+Residue/Mulch	Gross Revenue	56	16	17	0.057	5.87	0.4	15.7	0.12
Reduced Tillage+Residue/Mulch	Profit	101	26	29	0.211	23.49	-9.1	75.3	0.219

Discussion

Our analysis, supported by 198 studies and presented in Figures 1-2 and Tables 3-4, offers an in-depth examination of the economic implications of various agricultural NbS. This comprehensive synthesis is one of the most extensive economic evaluations of NbS or indeed changes in agricultural management to date(36), shedding significant light on potential economic benefits and challenges.

In this investigation, we concentrated on studies that specifically included information on profit, as opposed to the more commonly reported gross revenue. This choice was deliberate, as profit, which accounts for the costs, provides a more comprehensive and tangible understanding of the financial benefits received by the farmer(26). While nearly all the agricultural NbS showed an increase in gross revenue, this does not tell the whole story. When these revenue figures were examined in relation to the actual costs incurred in implementing the practices, the picture changed. The likelihood of realizing tangible financial benefits decreased, revealing that a mere increase in revenue does not necessarily translate to increased profitability. This differentiation between revenue and profit is crucial for understanding the true economic impact of these practices on farmers, allowing for a more nuanced and realistic assessment of the potential financial advantages or drawbacks and their potential to scale to greater use.

The finding that a reduction in fertilizer use—a core aspect of many NbS strategies—leads to a decrease in costs aligns with expectations of lower costs from reduced expenditures on fertilizers. However, lower costs are accompanied by a significant negative effect on mean profit highlight an essential and potentially challenging paradox. The practices that are environmentally favorable may not immediately translate into financial gains for the farmers. This seemingly contradictory outcome can be understood as part of a transitional phase where farmers are required to adapt to new nutrient dynamics in order to maintain or even enhance productivity(26). Such a transition may involve not only learning new practices but also overcoming barriers like initial investments in alternative methods, access to expertise, and possibly dealing with short-term yield fluctuations(37). What these findings emphasize is the necessity for thoughtful policy and support structures that can ease this transition, recognizing the long-term environmental benefits, but also the short-term challenges that farmers may face.

The findings related to the use of soil management strategies like biochar, cover crops, reduced tillage, and rotations present a complex picture of the cost and revenue dynamics associated with environmentally beneficial farming practices. Reduced tillage, another key NbS, shows a significant decrease in variable costs, suggesting potential economic benefits, and a trend towards increased profit. These changes might be attributed to the transitional soil dynamics as farmers move away from conventional tillage practices(38). Decoding these temporal adjustments and finding strategies to cushion any negative impacts will be vital for advocating the uptake of such practices. The increase in costs that comes with some of these NbS confirms previous understandings, reflecting the immediate investment required to purchase and apply these products or increases in labor demand. While they offer long-term benefits to soil health and

productivity, the upfront financial burden can be a considerable barrier to adoption, particularly for smallholder farmers in low- and middle-income countries who may lack the capital to make such investments. Yet, the study also reveals increases in gross revenue, indicating that the higher costs could be offset by increased revenues over time. Additionally, the conservation of crop residues and their use as mulch, though showing a non-significant positive contribution to profit, holds promise(39). By enhancing soil fertility and water retention and reducing the need for external inputs, this practice can increase returns, albeit subtly. Together, these insights underscore the complexity of integrating sustainable farming practices. They point to the need for targeted support, such as subsidies for soil amendments, educational outreach about long-term benefits, and tailored approaches for different scales of farming, to ensure that the long-term environmental gains of these practices are accessible and attractive to the diverse range of farmers responsible for their implementation.

It should be noted that some agricultural NbS, such as rotations, intercropping, biochar application, and cover cropping, were found to increase costs significantly, often in the range of 25% to 50% more than conventional farming practices. These increases can be attributed to the immediate investment required for materials, labor, and potential changes to equipment or farming techniques. For example, biochar requires procurement and application processes, while intercropping and rotations may necessitate a redesign of planting patterns and additional labor(21). Despite the potential benefits, the financial burden can be substantial. These barriers may deter some farmers, particularly smallholder farmers in resource-limited settings, from adopting these otherwise promising approaches(40). It underscores the importance of examining not only the environmental and productive gains from these practices but also the economic feasibility, particularly in the context of short-term financial constraints that many farmers face.

The practice of bundling multiple NbS together did not reveal the expected significant benefits in our analysis. Surprisingly, these bundled approaches often did not have much positive impact relative to NbS implemented separately. Whether this outcome was the result of increased costs associated with implementing multiple solutions simultaneously or other underlying factors remains unclear and warrants further investigation. This finding challenges the common assumption that combining various agricultural practices would necessarily yield compounded benefits, either economically or environmentally. The lack of a clear advantage in bundling NbS underscores the complexity of these interventions and the need for a nuanced understanding of how they interact. It also points to a potentially untapped area of research that could lead to more effective strategies for implementing NbS in the future.

Given the complexity of these challenges, there's a growing advocacy for pairing practices with complementary policies, creating what are termed as "socio-technical bundles", to facilitate broader adoption (41). While our data do not directly assess the effectiveness of these bundled approaches, they underscore the various areas where supportive actions can make a significant difference. For instance, policies and programs that provide financial incentives, training, or resources can address the immediate costs and learning curves associated with transitioning to

NbS. By integrating the insights from this study, policymakers can develop comprehensive strategies that not only foster the adoption of NbS but also ensure that these practices are accessible and attractive to a diverse range of farmers, including those in low- and middle-income countries. The following sections outline specific insights where policies may target.

Support for Transition Periods: The implementation of certain NbS may initially cause a decrease in profit, as observed in practices like reducing fertilizer use and reduced tillage. This transitional phase can be financially challenging for farmers, especially those operating on smaller scales. Policymakers should explore the establishment of support systems during these critical transition periods. This might include providing subsidies to offset initial losses, offering low-interest loans to finance the transition, or devising insurance programs to mitigate potential financial risks. Tailoring these supports to specific practices and local contexts will ensure that they effectively encourage adoption without jeopardizing farmers' immediate financial stability.

Investment in Soil Health: Soil health is fundamental to sustainable agriculture, and practices like soil amendment with biochar and organic materials represent vital steps in enhancing it. Our analysis highlights that these practices might increase initial costs, but others show they can lead to long-term improvements in soil health and productivity. Recognizing the potential barriers posed by these upfront costs, policymakers could incentivize these practices through carefully designed cost-share programs with those who invest in soil conservation. Such incentives would not only promote healthier soil but also potentially lead to increased yields and profits over time.

Promotion of Low-Cost NbS: Some NbS, such as conserving crop residues and using them as mulch, are found to result in increased profit, making them attractive options. However, wider adoption might require coordinated efforts to promote these practices among farmers and a nuanced understanding on how they fit within farming systems. Policymakers should consider implementing widespread promotion through extension services, farmer field schools, or community-based programs. By creating platforms that share knowledge and best practices, producers can be encouraged to adopt these low-cost strategies. Moreover, devising policies that reward farmers who successfully implement these practices, either through direct payments or recognition programs, can create a more conducive environment for scaling up these beneficial approaches.

Targeted Assistance for Smallholder Farmers: The financial implications of implementing NbS can be particularly challenging for smallholder farmers, especially in low- and middle-income countries where capital may be limited. Policymakers must understand that one-size-fits-all policies may not be effective. Instead, a more nuanced and targeted approach should be taken to assist these farmers. This includes providing technical assistance tailored to the specific needs and contexts of smallholders, facilitating access to affordable credit to make initial investments in NbS more attainable, and providing continuous training and support on the implementation and management of NbS. This multifaceted support would help ensures that smallholder farmers are not left behind in the transition towards more sustainable agricultural practices.

Conclusion

Our findings underscore a clear message: environmental sustainability and farmers' profitability aren't always aligned, but they can be. It is imperative to understand the complexities and barriers dictating the performance and adoption of each NbS across varied contexts. This understanding will pinpoint where sustainability and profitability can intersect and where supportive policies can help them more easily. For NbS to be universally embraced, policy interventions need to go beyond the rhetoric and directly address the tangible challenges faced by farmers respective to adoption NbS. Balancing sustainable practices with economic viability is not just desirable—it's essential for a sustainable agricultural future.

Acknowledgements

The World Bank supported this work. We edited the report using ChatGPT for readability.

References

1. Clark MA, Domingo NGG, Colgan K, Thakrar SK, Tilman D, Lynch J, et al. Global food system emissions could preclude achieving the 1.5° and 2°C climate change targets. Science. 2020;708(November):705–8.

2. Campbell BM, Beare DJ, Bennett EM, Hall-Spencer JM, Ingram JSI, Jaramillo F, et al. Agriculture production as a major driver of the earth system exceeding planetary boundaries. Ecol Soc. 2017;22(4).

3. Fuglie KO. Is agricultural productivity slowing? Glob Food Secur. 2018;17(January):73–83.

4. Erisman JW, Sutton MA, Galloway JN, Klimont Z, Winiwarter W. How a century of ammonia synthesis changed the world. Nat Geosci. 2008;1(10):636–9.

5. Sánchez AC, Estrada-Carmona N, Juventia SD, Jones SK. The impact of diversified farming practices on terrestrial biodiversity outcomes and agricultural yield worldwide: A systematic review protocol. Methods Protoc. 2021;4(1):1–24.

6. Challinor AJ, Watson J, Lobell DB, Howden SM, Smith DR, Chhetri N. A meta-analysis of crop yield under climate change and adaptation. Nat Clim Change. 2014;4(4):287–91.

7. Zabel F, Putzenlechner B, Mauser W. Global agricultural land resources - A high resolution suitability evaluation and its perspectives until 2100 under climate change conditions. PLoS ONE. 2014;9(9):1–12.

8. Tittonell P. Ecological intensification of agriculture—sustainable by nature. Curr Opin Environ Sustain. 2014 Jun;8:53–61.

9. Seddon N, Smith A, Smith P, Key I, Chausson A, Girardin C, et al. Getting the message right on nature-based solutions to climate change. Glob Change Biol. 2021;(September 2020):1–29.

10. Seddon N, Chausson A, Berry P, Girardin CAJ, Smith A, Turner B. Understanding the value and limits of nature-based solutions to climate change and other global challenges. Philos Trans R Soc B Biol Sci. 2020;375(1794).

11. Girardin CAJ, Jenkins S, Seddon N, Allen M, Lewis SL, Wheeler CE, et al. Nature-based solutions can help cool the planet — if we act now.

12. Zeppetello LRV, Cook-Patton SC, Parsons LA, Wolff NH, Kroeger T, Battisti DS, et al. Consistent cooling benefits of silvopasture in the tropics. Nat Commun. 2022;13(1):1–9.

13. Steward PR, Thierfelder C, Dougill AJ, Ligowe I. Conservation agriculture enhances resistance of maize to climate stress in a Malawian medium-term trial. Agric Ecosyst Environ. 2019;277(April 2018):95–104.

14. Giller KE, Hijbeek R, Andersson JA, Sumberg J. Regenerative Agriculture : An agronomic perspective. 2021; Available from: https://doi.org/10.1177/0030727021998063

15. Moinet GYK, Hijbeek R, van Vuuren DP, Giller KE. Carbon for soils, not soils for carbon. Glob Change Biol. 2023;(October 2022):1–15.

16. Altieri MA, Nicholls CI, Henao A, Lana MA. Agroecology and the design of climate change-resilient farming systems. Agron Sustain Dev. 2015;35:869–90.

17. Kuyah S, Öborn I, Jonsson M, Dahlin AS, Barrios E, Muthuri C, et al. Trees in agricultural landscapes enhance provision of ecosystem services in Sub-Saharan Africa. Int J Biodivers Sci Ecosyst Serv Manag. 2016;12(4):255–73.

18. Cardinael R, Umulisa V, Toudert A, Olivier A, Bockel L, Bernoux M. Revisiting IPCC Tier 1 coefficients for soil organic and biomass carbon storage in agroforestry systems. Environ Res Lett. 2018;1–25.

19. Kuyah S, Whitney CW, Jonsson M, Sileshi GW, Öborn I, Muthuri CW, et al. Agroforestry delivers a win-win solution for ecosystem services in sub-Saharan Africa . A meta-analysis. Agron Sustain Dev. 2019;8:39–47.

20. Jezeer RE, Santos MJ, Verweij PA, Boot RGA, Clough Y. Benefits for multiple ecosystem services in Peruvian coffee agroforestry systems without reducing yield. Vol. 40, ECOSYSTEM SERVICES. RADARWEG 29, 1043 NX AMSTERDAM, NETHERLANDS: ELSEVIER; 2019.

21. Himmelstein J, Ares A, Gallagher D, Myers J. A meta-analysis of intercropping in Africa: impacts on crop yield, farmer income, and integrated pest management effects. Int J Agric Sustain. 2017;15(1):1–10.

22. Snapp SS, Blackie MJ, Gilbert RA, Bezner-Kerr R, Kanyama-Phiri GY. Biodiversity can support a greener revolution in Africa. Proc Natl Acad Sci U S A. 2010;107(48):20840–5.

23. Pittelkow CM, Liang X, Linquist B a., van Groenigen KJ, Lee J, Lundy ME, et al. Productivity limits and potentials of the principles of conservation agriculture. Nature [Internet]. 2014 Oct 22 [cited 2014 Oct 22]; Available from: http://www.nature.com/doifinder/10.1038/nature13809

24. Cheesman S, Thierfelder C, Eash NS, Tesfahun G, Frossard E. Soil carbon stocks in conservation agriculture systems of Southern Africa. Soil Tillage Res. 2016;156:99–109.

25. Powlson DS, Stirling CM, Jat ML, Gerard BG, Palm CA, Sanchez PA, et al. Limited potential of no-till agriculture for climate change mitigation. Nat Clim Change. 2014 Jul 30;4(8):678–83.

26. Gram G, Roobroeck D, Pypers P, Six J, Merckx R, Vanlauwe B. Combining organic and mineral fertilizers as a climate-smart integrated soil fertility management practice in sub-Saharan Africa: A meta-analysis. PloS One. 2020;15(9):e0239552.

27. Zhang L, Zhou L, Wei J, Xu H, Tang Q, Tang J. Integrating cover crops with chicken grazing to improve soil nitrogen in rice fields and increase economic output. Sci TOTAL Environ. 2020;713(NA):NA.

28. Wang L, Li L, Xie J, Luo Z, Zhang R, Cai L, et al. Managing the trade-offs among yield, economic benefits and carbon and nitrogen footprints of wheat cropping in a semi-arid region of China. Sci TOTAL Environ. 2021;768(NA):NA.

29. Laajaj R, Macours K, Masso C, Thuita M, Vanlauwe B. Reconciling yield gains in agronomic trials with returns under African smallholder conditions. Sci Rep. 2020;10(1):1–15.

30. Erenstein O, Laxmi V. Zero tillage impacts in India's rice–wheat systems: A review. Soil Tillage Res. 2008 Jul;100(1–2):1–14.

31. Makate C, Makate M, Mango N, Siziba S. Increasing resilience of smallholder farmers to climate change through multiple adoption of proven climate-smart agriculture innovations. Lessons from Southern Africa. J Environ Manage. 2019;231(NA):858–68.

32. UNEP. Adaptation Gap Report 2021 The Gathering Storm - Adapting to Climate Change in a Post-pandemic World. Erscheinungsort nicht ermittelbar: United Nations; 2021.

33. Haddaway NR, Bethel A, Dicks LV, Koricheva J, Macura B, Petrokofsky G, et al. Eight problems with literature reviews and how to fix them. Nat Ecol Evol. 2020;

34. Gurevitch J, Koricheva J, Nakagawa S, Stewart G. Meta-analysis and the science of research synthesis. Nature. 2018;555(7695):175–82.

35. Porciello J, Ivanina M, Islam M, Einarson S, Hirsh H. Accelerating evidence-informed decision-making for the Sustainable Development Goals using machine learning Jaron. Nat Mach Intell. 2020;2:559–65.

36. Harris D, Orr A. Is rainfed agriculture really a pathway from poverty? Agric Syst [Internet]. 2013 Oct [cited 2013 Nov 7]; Available from: http://linkinghub.elsevier.com/retrieve/pii/S0308521X13001236

37. Arslan A, Floress K, Lamanna C, Lipper L, Asfaw S, Rosenstock TS. Barriers to the adoption of improved agricultural technologies: A meta-analysis for Africa. Rome, Italy: International Fund for Agricultural Development; 2020 p. 1–37.

38. Corbeels M, Naudin K, Whitbread AM, Kühne R, Letourmy P. Limits of conservation agricutlure to overcome low crop yields in sub-Saharan Africa. Nat Food [Internet]. 2020;1(July). Available from: http://dx.doi.org/10.1038/s43016-020-0114-x

39. Qin W, Hu C, Oenema O. Soil mulching significantly enhances yields and water and nitrogen use efficiencies of maize and wheat: a meta-analysis: Supplementary Information. Sci Rep. 2015;5:16210.

40. Dreschel P, Olaleye A, Adeoti A, Thiombiano L, Barry B, Vohland K. Adoption driver and constraints of resource conservation technologies in sub-Saharan Africa. 2005;1–21.

41. Barrett CB, Benton TG, Cooper KA, Fanzo J, Gandhi R, Herrero M, et al. Bundling innovations to transform agri-food systems. Nat Sustain. 2020;3(12):974–6.

Supplementary Information

Table S1 | Distribution of data by countries, studies, and observations.

NbS Practice	Countries	Studies	Observations
All NbS	34	198	7116
Reduced Tillage	15	48	621
Residue/Mulch	14	44	828
Reduced Fert	14	44	1191
Organic Fert	12	23	444
Reduced Tillage+Residue/Mulch	11	27	285
Rotation	10	19	193
Intercropping	10	17	358
Reduced Fert+Organic Fert	7	10	189
Reduced Irrigation	7	19	386
Agroforestry	6	9	190
Reduced Irrigation+Reduced Tillage	5	14	271
Intercropping+Reduced Tillage	5	4	36
Biochar	5	11	334
Reduced Erosion	4	4	53
Cover Crops	4	9	122
Reduced Fert+Residue/Mulch	3	3	56
Intercropping+Rotation	3	4	36
Reduced Fert+Reduced Tillage	3	3	124
Biochar+Reduced Fert	3	5	90
Reduced Tillage+Residue/Mulch+Rotation	3	4	34
IPM	3	4	31
Reduced Irrigation+Reduced Tillage+Residue/Mulch	2	5	78
Residue/Mulch+Rotation	2	3	17

Table S2 | Web of Science search strings used to discover NbS literature.

NBS	Complete Search String (NBS x Economic x Livestock Species X Country)	Hits	Open
Agroforestry	(agroforest* OR agrosilv* OR "evergreen agriculture" OR "farmer managed natural regeneration" OR FMNR OR taungya OR alleycrop* OR "alley crop*" OR alleysystem OR "alley system" OR alleyfarm* OR "alley farm*" OR "boundary plant*" OR "liv* fence*" OR hedgerow* OR "riparian buffer strip*" OR "riparian forest buffer*" OR windbreak* OR shelterbelt* OR "shelter belt*" OR "improved fallow*" OR silv*past* OR silv*arable* OR "tree belt*" OR agrosilvopasto* OR (parkland* AND (agric* OR farm*)) OR ((tree* OR management) NEAR shad*) OR ((plant* OR farm* OR barrier* OR "buffer strip*") NEAR shrub* NEAR contour) OR ((plant* OR farm* OR barrier* OR "buffer strip*") NEAR tree* NEAR contour)) AND ("benefit cost ratio" OR "benefit-cost ratio" OR BCR OR "benefit cost analy*" OR "benefit-cost analy*" OR "bottom line" OR "break even period*" OR "breakeven period*" OR "capital destruction" OR "cost benefit ratio" OR "cost-benefit ratio" OR "cost benefit analy*" OR "cost-benefit analy*" OR "cost effectiv* analy*" OR cost* OR debit* OR "discount* cash flow*" OR "earnings before interest tax" OR "econom* analy*" OR "econom* evaluation*" OR "econom* valuation*" OR "economic impact*" OR expense* OR "full time equivalent*" OR "gross added value*" OR "gross income*" OR "gross margin*" OR income* OR "interest rate*" OR labor* OR labour* OR lease OR "man day*" OR "man power" OR "net added value*" OR "net farm income*" OR "net income*" OR "net present value*" OR "net worth" OR "operating profit*" OR "opportunity cost*" OR "partial budget*" OR "payback period*" OR payment* OR profit* OR receipt* OR return* OR revenue* OR tax OR "turnoff rate*" OR "willingness to pay" OR "working day*" OR (("direct use" OR "direct-use" OR "passive use"OR "passive-use" OR "non market" OR "non-market" OR contingent OR consumptive OR consumption OR subsistence OR livelihood*) AND (value* OR valuation*)) OR financ*) AND (Afghanistan OR Albania OR Algeria OR Angola OR Argentina OR Armenia OR Azerbaijan OR Bangladesh OR Belarus OR Belize OR Benin OR Bhutan OR Bolivia OR Bosnia and Herzegovina OR Botswana OR Brazil OR Brunei Darussalam OR Bulgaria OR Burkina Faso OR Burundi OR Cabo Verde OR Cambodia OR Cameroon OR Central African Republic OR Chad OR China OR Colombia OR Comoros OR Congo OR Costa Rica OR Cote d'Ivoire OR Cuba OR Democratic Republic of the Congo OR Djibouti OR Dominica OR Dominican Republic OR East Timor (Timor-Leste) OR Ecuador OR Egypt OR El Salvador OR Equatorial Guinea OR Eritrea OR Eswatini (Swaziland) OR Ethiopia OR Fiji OR Gabon OR Gambia OR Georgia OR Ghana OR Grenada OR Guatemala OR Guinea OR Guinea-Bissau OR Guyana OR Haiti OR Honduras OR India OR Indonesia OR Iran OR Iraq OR Jamaica OR Jordan OR Kazakhstan OR Kenya OR Kiribati OR Kosovo OR Kyrgyzstan OR Laos OR Lebanon OR Lesotho OR Liberia OR Libya OR Macedonia (North Macedonia) OR Madagascar OR Malawi OR Malaysia OR Maldives OR Mali OR Marshall Islands OR Mauritania OR Mauritius OR Mexico OR Micronesia OR Moldova OR Mongolia OR Montenegro OR Morocco OR Mozambique OR Myanmar (Burma) OR Namibia OR Nepal OR Nicaragua OR Niger OR Nigeria OR Niue OR North Korea OR Pakistan OR Palau OR Papua New Guinea OR Paraguay OR Peru OR Philippines OR Republic of the Congo OR Russia OR Rwanda OR Saint Lucia OR Saint Vincent and the Grenadines OR Samoa OR Sao Tome and Principe OR Senegal OR Serbia OR Sierra Leone OR Solomon Islands OR Somalia OR South Africa OR South Sudan OR Sri Lanka OR Sudan OR Suriname OR Syria OR Tajikistan OR Tanzania OR Thailand OR Togo OR Tonga OR Tunisia OR Turkey OR Turkmenistan OR Tuvalu OR Uganda OR Ukraine OR Uzbekistan OR Vanuatu OR Venezuela OR Vietnam OR West Bank and Gaza OR Yemen OR Zambia OR Zimbabwe)	1851	775
Biochar	(biochar* OR agrichar*) AND ("benefit cost ratio" OR "benefit-cost ratio" OR BCR OR "benefit cost analy*" OR "benefit-cost analy*" OR "bottom line" OR "break even period*" OR "breakeven period*" OR "capital destruction" OR "cost benefit ratio" OR "cost-benefit ratio" OR "cost benefit analy*" OR "cost-benefit analy*" OR "cost effectiv* analy*" OR cost* OR debit* OR "discount* cash flow*" OR "earnings before interest tax" OR "econom* analy*" OR "econom* evaluation*" OR "econom* valuation*" OR "economic impact*" OR expense* OR "full time equivalent*" OR "gross added value*" OR "gross income*" OR "gross margin*" OR income* OR "interest rate*" OR labor* OR labour* OR lease OR "man day*" OR "man power" OR "net added value*" OR "net farm income*" OR "net income*" OR "net present value*" OR "net worth" OR "operating profit*" OR	491	179

	"opportunity cost*" OR "partial budget*" OR "payback period*" OR payment* OR profit* OR receipt* OR return* OR revenue* OR tax OR "turnoff rate*" OR "willingness to pay" OR "working day*" OR (("direct use" OR "direct-use" OR "passive use"OR "passive-use" OR "non market" OR "non-market" OR contingent OR consumptive OR consumption OR subsistence OR livelihood*) AND (value* OR valuation*)) OR financ*) AND (Afghanistan OR Albania OR Algeria OR Angola OR Argentina OR Armenia OR Azerbaijan OR Bangladesh OR Belarus OR Belize OR Benin OR Bhutan OR Bolivia OR Bosnia and Herzegovina OR Botswana OR Brazil OR Brunei Darussalam OR Bulgaria OR Burkina Faso OR Burundi OR Cabo Verde OR Cambodia OR Cameroon OR Central African Republic OR Chad OR China OR Colombia OR Comoros OR Congo OR Costa Rica OR Cote d'Ivoire OR Cuba OR Democratic Republic of the Congo OR Djibouti OR Dominica OR Dominican Republic OR East Timor (Timor-Leste) OR Ecuador OR Egypt OR El Salvador OR Equatorial Guinea OR Eritrea OR Eswatini (Swaziland) OR Ethiopia OR Fiji OR Gabon OR Gambia OR Georgia OR Ghana OR Grenada OR Guatemala OR Guinea OR Guinea-Bissau OR Guyana OR Haiti OR Honduras OR India OR Indonesia OR Iran OR Iraq OR Jamaica OR Jordan OR Kazakhstan OR Kenya OR Kiribati OR Kosovo OR Kyrgyzstan OR Laos OR Lebanon OR Lesotho OR Liberia OR Libya OR Macedonia (North Macedonia) OR Madagascar OR Malawi OR Malaysia OR Maldives OR Mali OR Marshall Islands OR Mauritania OR Mauritius OR Mexico OR Micronesia OR Moldova OR Mongolia OR Montenegro OR Morocco OR Mozambique OR Myanmar (Burma) OR Namibia OR Nepal OR Nicaragua OR Niger OR Nigeria OR Niue OR North Korea OR Pakistan OR Palau OR Papua New Guinea OR Paraguay OR Peru OR Philippines OR Republic of the Congo OR Russia OR Rwanda OR Saint Lucia OR Saint Vincent and the Grenadines OR Samoa OR Sao Tome and Principe OR Senegal OR Serbia OR Sierra Leone OR Solomon Islands OR Somalia OR South Africa OR South Sudan OR Sri Lanka OR Sudan OR Suriname OR Syria OR Tajikistan OR Tanzania OR Thailand OR Togo OR Tonga OR Tunisia OR Turkey OR Turkmenistan OR Tuvalu OR Uganda OR Ukraine OR Uzbekistan OR Vanuatu OR Venezuela OR Vietnam OR West Bank and Gaza OR Yemen OR Zambia OR Zimbabwe)		
Cover Crops	("conservation agriculture" OR "permanent soil cover" OR "permanent ground cover" OR "green manure" OR "cover crop*" OR covercrop* OR "ground cover" OR groundcover OR "legum* cover" OR "improv* fallow*") AND ("benefit cost ratio" OR "benefit-cost ratio" OR BCR OR "benefit cost analy*" OR "benefit-cost analy*" OR "bottom line" OR "break even period*" OR "breakeven period*" OR "capital destruction" OR "cost benefit ratio" OR "cost-benefit ratio" OR "cost benefit analy*" OR "cost-benefit analy*" OR "cost effectiv* analy*" OR cost* OR debit* OR "discount* cash flow*" OR "earnings before interest tax" OR "econom* analy*" OR "econom* evaluation*" OR "econom* valuation*" OR "economic impact*" OR expense* OR "full time equivalent*" OR "gross added value*" OR "gross income*" OR "gross margin*" OR income* OR "interest rate*" OR labor* OR labour* OR lease OR "man day*" OR "man power" OR "net added value*" OR "net farm income*" OR "net income*" OR "net present value*" OR "net worth" OR "operating profit*" OR "opportunity cost*" OR "partial budget*" OR "payback period*" OR payment* OR profit* OR receipt* OR return* OR revenue* OR tax OR "turnoff rate*" OR "willingness to pay" OR "working day*" OR (("direct use" OR "direct-use" OR "passive use"OR "passive-use" OR "non market" OR "non-market" OR contingent OR consumptive OR consumption OR subsistence OR livelihood*) AND (value* OR valuation*)) OR financ*) AND (Afghanistan OR Albania OR Algeria OR Angola OR Argentina OR Armenia OR Azerbaijan OR Bangladesh OR Belarus OR Belize OR Benin OR Bhutan OR Bolivia OR Bosnia and Herzegovina OR Botswana OR Brazil OR Brunei Darussalam OR Bulgaria OR Burkina Faso OR Burundi OR Cabo Verde OR Cambodia OR Cameroon OR Central African Republic OR Chad OR China OR Colombia OR Comoros OR Congo OR Costa Rica OR Cote d'Ivoire OR Cuba OR Democratic Republic of the Congo OR Djibouti OR Dominica OR Dominican Republic OR East Timor (Timor-Leste) OR Ecuador OR Egypt OR El Salvador OR Equatorial Guinea OR Eritrea OR Eswatini (Swaziland) OR Ethiopia OR Fiji OR Gabon OR Gambia OR Georgia OR Ghana OR Grenada OR Guatemala OR Guinea OR Guinea-Bissau OR Guyana OR Haiti OR Honduras OR India OR Indonesia OR Iran OR Iraq OR Jamaica OR Jordan OR Kazakhstan OR Kenya OR Kiribati OR Kosovo OR Kyrgyzstan OR Laos OR Lebanon OR Lesotho OR Liberia OR Libya OR Macedonia (North Macedonia) OR Madagascar OR Malawi OR Malaysia OR Maldives OR Mali OR Marshall Islands OR Mauritania OR Mauritius OR Mexico OR Micronesia OR Moldova OR Mongolia OR Montenegro OR Morocco OR Mozambique OR Myanmar (Burma) OR Namibia OR Nepal OR Nicaragua OR Niger OR Nigeria OR Niue OR	1050	405

	North Korea OR Pakistan OR Palau OR Papua New Guinea OR Paraguay OR Peru OR Philippines OR Republic of the Congo OR Russia OR Rwanda OR Saint Lucia OR Saint Vincent and the Grenadines OR Samoa OR Sao Tome and Principe OR Senegal OR Serbia OR Sierra Leone OR Solomon Islands OR Somalia OR South Africa OR South Sudan OR Sri Lanka OR Sudan OR Suriname OR Syria OR Tajikistan OR Tanzania OR Thailand OR Togo OR Tonga OR Tunisia OR Turkey OR Turkmenistan OR Tuvalu OR Uganda OR Ukraine OR Uzbekistan OR Vanuatu OR Venezuela OR Vietnam OR West Bank and Gaza OR Yemen OR Zambia OR Zimbabwe)		
Erosion Reduction	("stone lines" OR terrac* OR "soil and water conservation" OR "grass strips" OR "ridge and furrow" OR "planting basin" OR "basin planting" OR ("micro catchment" OR microcatchment) OR ((basin* OR pit*) NEAR "water harvesting") OR (fanya NEAR terrace*) OR (bund AND contour) OR ((rain* OR precipitation) NEAR harvest*) OR ((water OR rain* OR moisture) AND conservation NEAR in*situ) OR ((zai OR zay OR matengo OR plant) NEAR pit) OR (conservation NEAR tillage) OR "erosion reduction" OR "erosion prevention" OR "soil conservation" OR "erosion control" OR "soil protection" OR "erosion mitigation" OR "runoff reduction") AND ("benefit cost ratio" OR "benefit-cost ratio" OR BCR OR "benefit cost analy*" OR "benefit-cost analy*" OR "bottom line" OR "break even period*" OR "breakeven period*" OR "capital destruction" OR "cost benefit ratio" OR "cost-benefit ratio" OR "cost benefit analy*" OR "cost-benefit analy*" OR "cost effectiv* analy*" OR cost* OR debit* OR "discount* cash flow*" OR "earnings before interest tax" OR "econom* analy*" OR "econom* evaluation*" OR "econom* valuation*" OR "economic impact*" OR expense* OR "full time equivalent*" OR "gross added value*" OR "gross income*" OR "gross margin*" OR income* OR "interest rate*" OR labor* OR labour* OR lease OR "man day*" OR "man power" OR "net added value*" OR "net farm income*" OR "net income*" OR "net present value*" OR "net worth" OR "operating profit*" OR "opportunity cost*" OR "partial budget*" OR "payback period*" OR payment* OR profit* OR receipt* OR return* OR revenue* OR tax OR "turnoff rate*" OR "willingness to pay" OR "working day*" OR (("direct use" OR "direct-use" OR "passive use"OR "passive-use" OR "non market" OR "non-market" OR contingent OR consumptive OR consumption OR subsistence OR livelihood*) AND (value* OR valuation*)) OR financ*) AND (Afghanistan OR Albania OR Algeria OR Angola OR Argentina OR Armenia OR Azerbaijan OR Bangladesh OR Belarus OR Belize OR Benin OR Bhutan OR Bolivia OR Bosnia and Herzegovina OR Botswana OR Brazil OR Brunei Darussalam OR Bulgaria OR Burkina Faso OR Burundi OR Cabo Verde OR Cambodia OR Cameroon OR Central African Republic OR Chad OR China OR Colombia OR Comoros OR Congo OR Costa Rica OR Cote d'Ivoire OR Cuba OR Democratic Republic of the Congo OR Djibouti OR Dominica OR Dominican Republic OR East Timor (Timor-Leste) OR Ecuador OR Egypt OR El Salvador OR Equatorial Guinea OR Eritrea OR Eswatini (Swaziland) OR Ethiopia OR Fiji OR Gabon OR Gambia OR Georgia OR Ghana OR Grenada OR Guatemala OR Guinea OR Guinea-Bissau OR Guyana OR Haiti OR Honduras OR India OR Indonesia OR Iran OR Iraq OR Jamaica OR Jordan OR Kazakhstan OR Kenya OR Kiribati OR Kosovo OR Kyrgyzstan OR Laos OR Lebanon OR Lesotho OR Liberia OR Libya OR Macedonia (North Macedonia) OR Madagascar OR Malawi OR Malaysia OR Maldives OR Mali OR Marshall Islands OR Mauritania OR Mauritius OR Mexico OR Micronesia OR Moldova OR Mongolia OR Montenegro OR Morocco OR Mozambique OR Myanmar (Burma) OR Namibia OR Nepal OR Nicaragua OR Niger OR Nigeria OR Niue OR North Korea OR Pakistan OR Palau OR Papua New Guinea OR Paraguay OR Peru OR Philippines OR Republic of the Congo OR Russia OR Rwanda OR Saint Lucia OR Saint Vincent and the Grenadines OR Samoa OR Sao Tome and Principe OR Senegal OR Serbia OR Sierra Leone OR Solomon Islands OR Somalia OR South Africa OR South Sudan OR Sri Lanka OR Sudan OR Suriname OR Syria OR Tajikistan OR Tanzania OR Thailand OR Togo OR Tonga OR Tunisia OR Turkey OR Turkmenistan OR Tuvalu OR Uganda OR Ukraine OR Uzbekistan OR Vanuatu OR Venezuela OR Vietnam OR West Bank and Gaza OR Yemen OR Zambia OR Zimbabwe)	2249	837
Grazing Management	("managed grazing" OR "rotational grazing" OR "holistic planned grazing" OR "rational grazing" OR "intensive grazing" OR "short duration grazing" OR "high intensity low frequency grazing" OR "high intensity grazing" OR "mob grazing" OR "ultra-high stock density grazing" OR "biomass accumulation grazing" OR "strip grazing" OR "creep grazing" OR "forward grazing" OR "leader-follower grazing" OR "deferred grazing"	47	16

	OR "rest rotation grazing" OR "conservation grazing" OR "prescribed grazing" OR "targeted grazing" OR "multi-species grazing" OR "mixed grazing" OR "integrated grazing" OR "optimi$ed grazing" OR "grazing optimi$ation" OR "geofenced grazing" OR "virtual fencing" OR "GPS-based grazing" OR "electronic fencing") AND ("benefit cost ratio" OR "benefit-cost ratio" OR BCR OR "benefit cost analy*" OR "benefit-cost analy*" OR "bottom line" OR "break even period*" OR "breakeven period*" OR "capital destruction" OR "cost benefit ratio" OR "cost-benefit ratio" OR "cost benefit analy*" OR "cost-benefit analy*" OR "cost effectiv* analy*" OR cost* OR debit* OR "discount* cash flow*" OR "earnings before interest tax" OR "econom* analy*" OR "econom* evaluation*" OR "econom* valuation*" OR "economic impact*" OR expense* OR "full time equivalent*" OR "gross added value*" OR "gross income*" OR "gross margin*" OR income* OR "interest rate*" OR labor* OR labour* OR lease OR "man day*" OR "man power" OR "net added value*" OR "net farm income*" OR "net income*" OR "net present value*" OR "net worth" OR "operating profit*" OR "opportunity cost*" OR "partial budget*" OR "payback period*" OR payment* OR profit* OR receipt* OR return* OR revenue* OR tax OR "turnoff rate*" OR "willingness to pay" OR "working day*" OR (("direct use" OR "direct-use" OR "passive use"OR "passive-use" OR "non market" OR "non-market" OR contingent OR consumptive OR consumption OR subsistence OR livelihood*) AND (value* OR valuation*)) OR financ*) AND (livestock OR cattle OR sheep OR goats OR ruminant OR buffalo) AND (Afghanistan OR Albania OR Algeria OR Angola OR Argentina OR Armenia OR Azerbaijan OR Bangladesh OR Belarus OR Belize OR Benin OR Bhutan OR Bolivia OR Bosnia and Herzegovina OR Botswana OR Brazil OR Brunei Darussalam OR Bulgaria OR Burkina Faso OR Burundi OR Cabo Verde OR Cambodia OR Cameroon OR Central African Republic OR Chad OR China OR Colombia OR Comoros OR Congo OR Costa Rica OR Cote d'Ivoire OR Cuba OR Democratic Republic of the Congo OR Djibouti OR Dominica OR Dominican Republic OR East Timor (Timor-Leste) OR Ecuador OR Egypt OR El Salvador OR Equatorial Guinea OR Eritrea OR Eswatini (Swaziland) OR Ethiopia OR Fiji OR Gabon OR Gambia OR Georgia OR Ghana OR Grenada OR Guatemala OR Guinea OR Guinea-Bissau OR Guyana OR Haiti OR Honduras OR India OR Indonesia OR Iran OR Iraq OR Jamaica OR Jordan OR Kazakhstan OR Kenya OR Kiribati OR Kosovo OR Kyrgyzstan OR Laos OR Lebanon OR Lesotho OR Liberia OR Libya OR Macedonia (North Macedonia) OR Madagascar OR Malawi OR Malaysia OR Maldives OR Mali OR Marshall Islands OR Mauritania OR Mauritius OR Mexico OR Micronesia OR Moldova OR Mongolia OR Montenegro OR Morocco OR Mozambique OR Myanmar (Burma) OR Namibia OR Nepal OR Nicaragua OR Niger OR Nigeria OR Niue OR North Korea OR Pakistan OR Palau OR Papua New Guinea OR Paraguay OR Peru OR Philippines OR Republic of the Congo OR Russia OR Rwanda OR Saint Lucia OR Saint Vincent and the Grenadines OR Samoa OR Sao Tome and Principe OR Senegal OR Serbia OR Sierra Leone OR Solomon Islands OR Somalia OR South Africa OR South Sudan OR Sri Lanka OR Sudan OR Suriname OR Syria OR Tajikistan OR Tanzania OR Thailand OR Togo OR Tonga OR Tunisia OR Turkey OR Turkmenistan OR Tuvalu OR Uganda OR Ukraine OR Uzbekistan OR Vanuatu OR Venezuela OR Vietnam OR West Bank and Gaza OR Yemen OR Zambia OR Zimbabwe)		
High Energy Feeds	((((grain OR concentrate OR energy) NEAR (feed OR diet OR fodder OR ration)) AND ((grain OR concentrate OR energy) NEAR (high* OR increas* OR add* OR supplement* OR replace*))) OR "concentrate feeding" OR "energy supplementation" OR "high energy feed*" OR "grain feed" OR "high-concentrate diet" OR "high-grain diet" OR "corn-based diet" OR "intensive feeding" OR "high-energy diet") AND ("benefit cost ratio" OR "benefit-cost ratio" OR BCR OR "benefit cost analy*" OR "benefit-cost analy*" OR "bottom line" OR "break even period*" OR "breakeven period*" OR "capital destruction" OR "cost benefit ratio" OR "cost-benefit ratio" OR "cost benefit analy*" OR "cost-benefit analy*" OR "cost effectiv* analy*" OR cost* OR debit* OR "discount* cash flow*" OR "earnings before interest tax" OR "econom* analy*" OR "econom* evaluation*" OR "econom* valuation*" OR "economic impact*" OR expense* OR "full time equivalent*" OR "gross added value*" OR "gross income*" OR "gross margin*" OR income* OR "interest rate*" OR labor* OR labour* OR lease OR "man day*" OR "man power" OR "net added value*" OR "net farm income*" OR "net income*" OR "net present value*" OR "net worth" OR "operating profit*" OR "opportunity cost*" OR "partial budget*" OR "payback period*" OR payment* OR profit* OR receipt* OR return* OR revenue* OR tax OR "turnoff rate*" OR "willingness to pay" OR "working day*" OR (("direct use" OR "direct-use" OR "passive use"OR "passive-use" OR "non market" OR "non-market" OR contingent OR consumptive	186	83

	OR consumption OR subsistence OR livelihood*) AND (value* OR valuation*)) OR financ*) AND (livestock OR cattle OR sheep OR goats OR ruminant OR buffalo) AND (Afghanistan OR Albania OR Algeria OR Angola OR Argentina OR Armenia OR Azerbaijan OR Bangladesh OR Belarus OR Belize OR Benin OR Bhutan OR Bolivia OR Bosnia and Herzegovina OR Botswana OR Brazil OR Brunei Darussalam OR Bulgaria OR Burkina Faso OR Burundi OR Cabo Verde OR Cambodia OR Cameroon OR Central African Republic OR Chad OR China OR Colombia OR Comoros OR Congo OR Costa Rica OR Cote d'Ivoire OR Cuba OR Democratic Republic of the Congo OR Djibouti OR Dominica OR Dominican Republic OR East Timor (Timor-Leste) OR Ecuador OR Egypt OR El Salvador OR Equatorial Guinea OR Eritrea OR Eswatini (Swaziland) OR Ethiopia OR Fiji OR Gabon OR Gambia OR Georgia OR Ghana OR Grenada OR Guatemala OR Guinea OR Guinea-Bissau OR Guyana OR Haiti OR Honduras OR India OR Indonesia OR Iran OR Iraq OR Jamaica OR Jordan OR Kazakhstan OR Kenya OR Kiribati OR Kosovo OR Kyrgyzstan OR Laos OR Lebanon OR Lesotho OR Liberia OR Libya OR Macedonia (North Macedonia) OR Madagascar OR Malawi OR Malaysia OR Maldives OR Mali OR Marshall Islands OR Mauritania OR Mauritius OR Mexico OR Micronesia OR Moldova OR Mongolia OR Montenegro OR Morocco OR Mozambique OR Myanmar (Burma) OR Namibia OR Nepal OR Nicaragua OR Niger OR Nigeria OR Niue OR North Korea OR Pakistan OR Palau OR Papua New Guinea OR Paraguay OR Peru OR Philippines OR Republic of the Congo OR Russia OR Rwanda OR Saint Lucia OR Saint Vincent and the Grenadines OR Samoa OR Sao Tome and Principe OR Senegal OR Serbia OR Sierra Leone OR Solomon Islands OR Somalia OR South Africa OR South Sudan OR Sri Lanka OR Sudan OR Suriname OR Syria OR Tajikistan OR Tanzania OR Thailand OR Togo OR Tonga OR Tunisia OR Turkey OR Turkmenistan OR Tuvalu OR Uganda OR Ukraine OR Uzbekistan OR Vanuatu OR Venezuela OR Vietnam OR West Bank and Gaza OR Yemen OR Zambia OR Zimbabwe)		
Intercropping	("cropping system diversification" OR "crop diversification" OR "diversif* crop*" OR polycultur* OR "relay crop*" OR (legum* NEAR (intercrop* OR "inter crop*")) OR (divers* NEAR (farm* OR agric* OR "food system"))) AND ("benefit cost ratio" OR "benefit-cost ratio" OR BCR OR "benefit cost analy*" OR "benefit-cost analy*" OR "bottom line" OR "break even period*" OR "breakeven period*" OR "capital destruction" OR "cost benefit ratio" OR "cost-benefit ratio" OR "cost benefit analy*" OR "cost-benefit analy*" OR "cost effectiv* analy*" OR cost* OR debit* OR "discount* cash flow*" OR "earnings before interest tax" OR "econom* analy*" OR "econom* evaluation*" OR "econom* valuation*" OR "economic impact*" OR expense* OR "full time equivalent*" OR "gross added value*" OR "gross income*" OR "gross margin*" OR income* OR "interest rate*" OR labor* OR labour* OR lease OR "man day*" OR "man power" OR "net added value*" OR "net farm income*" OR "net income*" OR "net present value*" OR "net worth" OR "operating profit*" OR "opportunity cost*" OR "partial budget*" OR "payback period*" OR payment* OR profit* OR receipt* OR return* OR revenue* OR tax OR "turnoff rate*" OR "willingness to pay" OR "working day*" OR (("direct use" OR "direct-use" OR "passive use"OR "passive-use" OR "non market" OR "non-market" OR contingent OR consumptive OR consumption OR subsistence OR livelihood*) AND (value* OR valuation*)) OR financ*) AND (Afghanistan OR Albania OR Algeria OR Angola OR Argentina OR Armenia OR Azerbaijan OR Bangladesh OR Belarus OR Belize OR Benin OR Bhutan OR Bolivia OR Bosnia and Herzegovina OR Botswana OR Brazil OR Brunei Darussalam OR Bulgaria OR Burkina Faso OR Burundi OR Cabo Verde OR Cambodia OR Cameroon OR Central African Republic OR Chad OR China OR Colombia OR Comoros OR Congo OR Costa Rica OR Cote d'Ivoire OR Cuba OR Democratic Republic of the Congo OR Djibouti OR Dominica OR Dominican Republic OR East Timor (Timor-Leste) OR Ecuador OR Egypt OR El Salvador OR Equatorial Guinea OR Eritrea OR Eswatini (Swaziland) OR Ethiopia OR Fiji OR Gabon OR Gambia OR Georgia OR Ghana OR Grenada OR Guatemala OR Guinea OR Guinea-Bissau OR Guyana OR Haiti OR Honduras OR India OR Indonesia OR Iran OR Iraq OR Jamaica OR Jordan OR Kazakhstan OR Kenya OR Kiribati OR Kosovo OR Kyrgyzstan OR Laos OR Lebanon OR Lesotho OR Liberia OR Libya OR Macedonia (North Macedonia) OR Madagascar OR Malawi OR Malaysia OR Maldives OR Mali OR Marshall Islands OR Mauritania OR Mauritius OR Mexico OR Micronesia OR Moldova OR Mongolia OR Montenegro OR Morocco OR Mozambique OR Myanmar (Burma) OR Namibia OR Nepal OR Nicaragua OR Niger OR Nigeria OR Niue OR North Korea OR Pakistan OR Palau OR Papua New Guinea OR Paraguay OR Peru OR Philippines OR Republic of the Congo OR Russia OR	2762	1279

	Rwanda OR Saint Lucia OR Saint Vincent and the Grenadines OR Samoa OR Sao Tome and Principe OR Senegal OR Serbia OR Sierra Leone OR Solomon Islands OR Somalia OR South Africa OR South Sudan OR Sri Lanka OR Sudan OR Suriname OR Syria OR Tajikistan OR Tanzania OR Thailand OR Togo OR Tonga OR Tunisia OR Turkey OR Turkmenistan OR Tuvalu OR Uganda OR Ukraine OR Uzbekistan OR Vanuatu OR Venezuela OR Vietnam OR West Bank and Gaza OR Yemen OR Zambia OR Zimbabwe)		
IPM	(IPM OR "integrated pest control" OR ((pest* OR insect* OR weeds* OR pathogen*) NEAR "action threshold*") OR ((pest* OR insect* OR weed* OR pathogen*) NEAR "econom* threshold*") OR "integrated pest control" OR "integrated plant protection" OR "biological control" OR "ecological pest management" OR "sustainable pest management") AND ("benefit cost ratio" OR "benefit-cost ratio" OR BCR OR "benefit cost analy*" OR "benefit-cost analy*" OR "bottom line" OR "break even period*" OR "breakeven period*" OR "capital destruction" OR "cost benefit ratio" OR "cost-benefit ratio" OR "cost benefit analy*" OR "cost-benefit analy*" OR "cost effectiv* analy*" OR cost* OR debit* OR "discount* cash flow*" OR "earnings before interest tax" OR "econom* analy*" OR "econom* evaluation*" OR "econom* valuation*" OR "economic impact*" OR expense* OR "full time equivalent*" OR "gross added value*" OR "gross income*" OR "gross margin*" OR income* OR "interest rate*" OR labor* OR labour* OR lease OR "man day*" OR "man power" OR "net added value*" OR "net farm income*" OR "net income*" OR "net present value*" OR "net worth" OR "operating profit*" OR "opportunity cost*" OR "partial budget*" OR "payback period*" OR payment* OR profit* OR receipt* OR return* OR revenue* OR tax OR "turnoff rate*" OR "willingness to pay" OR "working day*" OR (("direct use" OR "direct-use" OR "passive use"OR "passive-use" OR "non market" OR "non-market" OR contingent OR consumptive OR consumption OR subsistence OR livelihood*) AND (value* OR valuation*)) OR financ*) AND (Afghanistan OR Albania OR Algeria OR Angola OR Argentina OR Armenia OR Azerbaijan OR Bangladesh OR Belarus OR Belize OR Benin OR Bhutan OR Bolivia OR Bosnia and Herzegovina OR Botswana OR Brazil OR Brunei Darussalam OR Bulgaria OR Burkina Faso OR Burundi OR Cabo Verde OR Cambodia OR Cameroon OR Central African Republic OR Chad OR China OR Colombia OR Comoros OR Congo OR Costa Rica OR Cote d'Ivoire OR Cuba OR Democratic Republic of the Congo OR Djibouti OR Dominica OR Dominican Republic OR East Timor (Timor-Leste) OR Ecuador OR Egypt OR El Salvador OR Equatorial Guinea OR Eritrea OR Eswatini (Swaziland) OR Ethiopia OR Fiji OR Gabon OR Gambia OR Georgia OR Ghana OR Grenada OR Guatemala OR Guinea OR Guinea-Bissau OR Guyana OR Haiti OR Honduras OR India OR Indonesia OR Iran OR Iraq OR Jamaica OR Jordan OR Kazakhstan OR Kenya OR Kiribati OR Kosovo OR Kyrgyzstan OR Laos OR Lebanon OR Lesotho OR Liberia OR Libya OR Macedonia (North Macedonia) OR Madagascar OR Malawi OR Malaysia OR Maldives OR Mali OR Marshall Islands OR Mauritania OR Mauritius OR Mexico OR Micronesia OR Moldova OR Mongolia OR Montenegro OR Morocco OR Mozambique OR Myanmar (Burma) OR Namibia OR Nepal OR Nicaragua OR Niger OR Nigeria OR Niue OR North Korea OR Pakistan OR Palau OR Papua New Guinea OR Paraguay OR Peru OR Philippines OR Republic of the Congo OR Russia OR Rwanda OR Saint Lucia OR Saint Vincent and the Grenadines OR Samoa OR Sao Tome and Principe OR Senegal OR Serbia OR Sierra Leone OR Solomon Islands OR Somalia OR South Africa OR South Sudan OR Sri Lanka OR Sudan OR Suriname OR Syria OR Tajikistan OR Tanzania OR Thailand OR Togo OR Tonga OR Tunisia OR Turkey OR Turkmenistan OR Tuvalu OR Uganda OR Ukraine OR Uzbekistan OR Vanuatu OR Venezuela OR Vietnam OR West Bank and Gaza OR Yemen OR Zambia OR Zimbabwe)	1903	792
Legumes in Pasture	((nitrogen$fixing OR legume* OR leguminous OR clover* OR bean* OR pulse* OR trifolium OR medicago OR medic OR alfalfa OR lotus OR trefoil OR vicia OR vetch OR lespedeza OR onobrychis OR glycine OR astragalus OR macroptilium OR stylo* OR desmodium OR centrosema OR pueraria OR arachis OR leucaena OR alysicarpus OR mucuna OR crotalaria Or lablab OR tephrosia OR meliotus OR securigera OR trigonella OR chamaecrista OR neonotonia OR aeschynomene OR hedysarum OR ornithopus OR cajanus OR calopogonium OR canavalia OR clitoria OR dorycnium OR galega OR lupinus OR kummerowia OR phaseolus OR psoralea OR lotononis OR macrotyloma OR biserrula) NEAR (pasture* OR paddock* OR meadow* OR rangeland* OR overseed* OR interseed* OR intercrop* OR improv* OR enrich* OR enhance* OR optim* OR addition))	120	48

	AND ("benefit cost ratio" OR "benefit-cost ratio" OR BCR OR "benefit cost analy*" OR "benefit-cost analy*" OR "bottom line" OR "break even period*" OR "breakeven period*" OR "capital destruction" OR "cost benefit ratio" OR "cost-benefit ratio" OR "cost benefit analy*" OR "cost-benefit analy*" OR "cost effectiv* analy*" OR cost* OR debit* OR "discount* cash flow*" OR "earnings before interest tax" OR "econom* analy*" OR "econom* evaluation*" OR "econom* valuation*" OR "economic impact*" OR expense* OR "full time equivalent*" OR "gross added value*" OR "gross income*" OR "gross margin*" OR income* OR "interest rate*" OR labor* OR labour* OR lease OR "man day*" OR "man power" OR "net added value*" OR "net farm income*" OR "net income*" OR "net present value*" OR "net worth" OR "operating profit*" OR "opportunity cost*" OR "partial budget*" OR "payback period*" OR payment* OR profit* OR receipt* OR return* OR revenue* OR tax OR "turnoff rate*" OR "willingness to pay" OR "working day*" OR (("direct use" OR "direct-use" OR "passive use"OR "passive-use" OR "non market" OR "non-market" OR contingent OR consumptive OR consumption OR subsistence OR livelihood*) AND (value* OR valuation*)) OR financ*) AND (livestock OR cattle OR sheep OR goats OR ruminant OR buffalo) AND (Afghanistan OR Albania OR Algeria OR Angola OR Argentina OR Armenia OR Azerbaijan OR Bangladesh OR Belarus OR Belize OR Benin OR Bhutan OR Bolivia OR Bosnia and Herzegovina OR Botswana OR Brazil OR Brunei Darussalam OR Bulgaria OR Burkina Faso OR Burundi OR Cabo Verde OR Cambodia OR Cameroon OR Central African Republic OR Chad OR China OR Colombia OR Comoros OR Congo OR Costa Rica OR Cote d'Ivoire OR Cuba OR Democratic Republic of the Congo OR Djibouti OR Dominica OR Dominican Republic OR East Timor (Timor-Leste) OR Ecuador OR Egypt OR El Salvador OR Equatorial Guinea OR Eritrea OR Eswatini (Swaziland) OR Ethiopia OR Fiji OR Gabon OR Gambia OR Georgia OR Ghana OR Grenada OR Guatemala OR Guinea OR Guinea-Bissau OR Guyana OR Haiti OR Honduras OR India OR Indonesia OR Iran OR Iraq OR Jamaica OR Jordan OR Kazakhstan OR Kenya OR Kiribati OR Kosovo OR Kyrgyzstan OR Laos OR Lebanon OR Lesotho OR Liberia OR Libya OR Macedonia (North Macedonia) OR Madagascar OR Malawi OR Malaysia OR Maldives OR Mali OR Marshall Islands OR Mauritania OR Mauritius OR Mexico OR Micronesia OR Moldova OR Mongolia OR Montenegro OR Morocco OR Mozambique OR Myanmar (Burma) OR Namibia OR Nepal OR Nicaragua OR Niger OR Nigeria OR Niue OR North Korea OR Pakistan OR Palau OR Papua New Guinea OR Paraguay OR Peru OR Philippines OR Republic of the Congo OR Russia OR Rwanda OR Saint Lucia OR Saint Vincent and the Grenadines OR Samoa OR Sao Tome and Principe OR Senegal OR Serbia OR Sierra Leone OR Solomon Islands OR Somalia OR South Africa OR South Sudan OR Sri Lanka OR Sudan OR Suriname OR Syria OR Tajikistan OR Tanzania OR Thailand OR Togo OR Tonga OR Tunisia OR Turkey OR Turkmenistan OR Tuvalu OR Uganda OR Ukraine OR Uzbekistan OR Vanuatu OR Venezuela OR Vietnam OR West Bank and Gaza OR Yemen OR Zambia OR Zimbabwe)		
Mulch	("conservation agriculture" OR mulch* OR "residue ret*" OR "residue kept" OR ("organic residue*" AND soil) OR (stubble NEAR tillage)) AND ("benefit cost ratio" OR "benefit-cost ratio" OR BCR OR "benefit cost analy*" OR "benefit-cost analy*" OR "bottom line" OR "break even period*" OR "breakeven period*" OR "capital destruction" OR "cost benefit ratio" OR "cost-benefit ratio" OR "cost benefit analy*" OR "cost-benefit analy*" OR "cost effectiv* analy*" OR cost* OR debit* OR "discount* cash flow*" OR "earnings before interest tax" OR "econom* analy*" OR "econom* evaluation*" OR "econom* valuation*" OR "economic impact*" OR expense* OR "full time equivalent*" OR "gross added value*" OR "gross income*" OR "gross margin*" OR income* OR "interest rate*" OR labor* OR labour* OR lease OR "man day*" OR "man power" OR "net added value*" OR "net farm income*" OR "net income*" OR "net present value*" OR "net worth" OR "operating profit*" OR "opportunity cost*" OR "partial budget*" OR "payback period*" OR payment* OR profit* OR receipt* OR return* OR revenue* OR tax OR "turnoff rate*" OR "willingness to pay" OR "working day*" OR (("direct use" OR "direct-use" OR "passive use"OR "passive-use" OR "non market" OR "non-market" OR contingent OR consumptive OR consumption OR subsistence OR livelihood*) AND (value* OR valuation*)) OR financ*) AND (Afghanistan OR Albania OR Algeria OR Angola OR Argentina OR Armenia OR Azerbaijan OR Bangladesh OR Belarus OR Belize OR Benin OR Bhutan OR Bolivia OR Bosnia and Herzegovina OR Botswana OR Brazil OR Brunei Darussalam OR Bulgaria OR Burkina Faso OR Burundi OR Cabo Verde OR Cambodia OR Cameroon OR Central African Republic OR Chad OR China OR Colombia OR Comoros OR Congo OR Costa Rica OR Cote d'Ivoire OR Cuba OR	1398	496

	Democratic Republic of the Congo OR Djibouti OR Dominica OR Dominican Republic OR East Timor (Timor-Leste) OR Ecuador OR Egypt OR El Salvador OR Equatorial Guinea OR Eritrea OR Eswatini (Swaziland) OR Ethiopia OR Fiji OR Gabon OR Gambia OR Georgia OR Ghana OR Grenada OR Guatemala OR Guinea OR Guinea-Bissau OR Guyana OR Haiti OR Honduras OR India OR Indonesia OR Iran OR Iraq OR Jamaica OR Jordan OR Kazakhstan OR Kenya OR Kiribati OR Kosovo OR Kyrgyzstan OR Laos OR Lebanon OR Lesotho OR Liberia OR Libya OR Macedonia (North Macedonia) OR Madagascar OR Malawi OR Malaysia OR Maldives OR Mali OR Marshall Islands OR Mauritania OR Mauritius OR Mexico OR Micronesia OR Moldova OR Mongolia OR Montenegro OR Morocco OR Mozambique OR Myanmar (Burma) OR Namibia OR Nepal OR Nicaragua OR Niger OR Nigeria OR Niue OR North Korea OR Pakistan OR Palau OR Papua New Guinea OR Paraguay OR Peru OR Philippines OR Republic of the Congo OR Russia OR Rwanda OR Saint Lucia OR Saint Vincent and the Grenadines OR Samoa OR Sao Tome and Principe OR Senegal OR Serbia OR Sierra Leone OR Solomon Islands OR Somalia OR South Africa OR South Sudan OR Sri Lanka OR Sudan OR Suriname OR Syria OR Tajikistan OR Tanzania OR Thailand OR Togo OR Tonga OR Tunisia OR Turkey OR Turkmenistan OR Tuvalu OR Uganda OR Ukraine OR Uzbekistan OR Vanuatu OR Venezuela OR Vietnam OR West Bank and Gaza OR Yemen OR Zambia OR Zimbabwe)		
Nutrient Management	("Integrated soil fertility management" OR "integrated soil nutrient management" OR "soil amendment" OR "organic input*" OR "organic amendment*" OR ("organic residue*" AND soil) OR (soil NEAR manure) OR (soil NEAR "animal waste") OR (compost* NEAR soil) OR ("soil organic matter" NEAR management) OR (soil NEAR biofertili*) OR (soil NEAR bioinput) OR (soil NEAR biosolid) OR (stubble NEAR tillage)) AND ("benefit cost ratio" OR "benefit-cost ratio" OR BCR OR "benefit cost analy*" OR "benefit-cost analy*" OR "bottom line" OR "break even period*" OR "breakeven period*" OR "capital destruction" OR "cost benefit ratio" OR "cost-benefit ratio" OR "cost benefit analy*" OR "cost-benefit analy*" OR "cost effectiv* analy*" OR cost* OR debit* OR "discount* cash flow*" OR "earnings before interest tax" OR "econom* analy*" OR "econom* evaluation*" OR "econom* valuation*" OR "economic impact*" OR expense* OR "full time equivalent*" OR "gross added value*" OR "gross income*" OR "gross margin*" OR income* OR "interest rate*" OR labor* OR labour* OR lease OR "man day*" OR "man power" OR "net added value*" OR "net farm income*" OR "net income*" OR "net present value*" OR "net worth" OR "operating profit*" OR "opportunity cost*" OR "partial budget*" OR "payback period*" OR payment* OR profit* OR receipt* OR return* OR revenue* OR tax OR "turnoff rate*" OR "willingness to pay" OR "working day*" OR (("direct use" OR "direct-use" OR "passive use"OR "passive-use" OR "non market" OR "non-market" OR contingent OR consumptive OR consumption OR subsistence OR livelihood*) AND (value* OR valuation*)) OR financ*) AND (Afghanistan OR Albania OR Algeria OR Angola OR Argentina OR Armenia OR Azerbaijan OR Bangladesh OR Belarus OR Belize OR Benin OR Bhutan OR Bolivia OR Bosnia and Herzegovina OR Botswana OR Brazil OR Brunei Darussalam OR Bulgaria OR Burkina Faso OR Burundi OR Cabo Verde OR Cambodia OR Cameroon OR Central African Republic OR Chad OR China OR Colombia OR Comoros OR Congo OR Costa Rica OR Cote d'Ivoire OR Cuba OR Democratic Republic of the Congo OR Djibouti OR Dominica OR Dominican Republic OR East Timor (Timor-Leste) OR Ecuador OR Egypt OR El Salvador OR Equatorial Guinea OR Eritrea OR Eswatini (Swaziland) OR Ethiopia OR Fiji OR Gabon OR Gambia OR Georgia OR Ghana OR Grenada OR Guatemala OR Guinea OR Guinea-Bissau OR Guyana OR Haiti OR Honduras OR India OR Indonesia OR Iran OR Iraq OR Jamaica OR Jordan OR Kazakhstan OR Kenya OR Kiribati OR Kosovo OR Kyrgyzstan OR Laos OR Lebanon OR Lesotho OR Liberia OR Libya OR Macedonia (North Macedonia) OR Madagascar OR Malawi OR Malaysia OR Maldives OR Mali OR Marshall Islands OR Mauritania OR Mauritius OR Mexico OR Micronesia OR Moldova OR Mongolia OR Montenegro OR Morocco OR Mozambique OR Myanmar (Burma) OR Namibia OR Nepal OR Nicaragua OR Niger OR Nigeria OR Niue OR North Korea OR Pakistan OR Palau OR Papua New Guinea OR Paraguay OR Peru OR Philippines OR Republic of the Congo OR Russia OR Rwanda OR Saint Lucia OR Saint Vincent and the Grenadines OR Samoa OR Sao Tome and Principe OR Senegal OR Serbia OR Sierra Leone OR Solomon Islands OR Somalia OR South Africa OR South Sudan OR Sri Lanka OR Sudan OR Suriname OR Syria OR Tajikistan OR Tanzania OR Thailand OR Togo OR Tonga OR Tunisia OR Turkey OR Turkmenistan OR Tuvalu OR Uganda OR Ukraine OR Uzbekistan OR Vanuatu OR Venezuela OR Vietnam OR West Bank and Gaza OR Yemen OR Zambia OR Zimbabwe)	951	345

Reduced Tillage	("conservation agriculture" OR "direct seed*" OR "direct sowing" OR "direct plant*" OR "direct drill*" OR "no till*" OR "reduced till*" OR "min* till*" OR "zero till*" OR "minimum soil disturbance" OR "limit* soil disturbance" OR "stale seed bed" OR "dibble stick" OR ripper OR ripline OR ripping OR ("soil organic matter" NEAR management) OR (strip NEAR tillage)) AND ("benefit cost ratio" OR "benefit-cost ratio" OR BCR OR "benefit cost analy*" OR "benefit-cost analy*" OR "bottom line" OR "break even period*" OR "breakeven period*" OR "capital destruction" OR "cost benefit ratio" OR "cost-benefit ratio" OR "cost benefit analy*" OR "cost-benefit analy*" OR "cost effectiv* analy*" OR cost* OR debit* OR "discount* cash flow*" OR "earnings before interest tax" OR "econom* analy*" OR "econom* evaluation*" OR "econom* valuation*" OR "economic impact*" OR expense* OR "full time equivalent*" OR "gross added value*" OR "gross income*" OR "gross margin*" OR income* OR "interest rate*" OR labor* OR labour* OR lease OR "man day*" OR "man power" OR "net added value*" OR "net farm income*" OR "net income*" OR "net present value*" OR "net worth" OR "operating profit*" OR "opportunity cost*" OR "partial budget*" OR "payback period*" OR payment* OR profit* OR receipt* OR return* OR revenue* OR tax OR "turnoff rate*" OR "willingness to pay" OR "working day*" OR (("direct use" OR "direct-use" OR "passive use"OR "passive-use" OR "non market" OR "non-market" OR contingent OR consumptive OR consumption OR subsistence OR livelihood*) AND (value* OR valuation*)) OR financ*) AND (Afghanistan OR Albania OR Algeria OR Angola OR Argentina OR Armenia OR Azerbaijan OR Bangladesh OR Belarus OR Belize OR Benin OR Bhutan OR Bolivia OR Bosnia and Herzegovina OR Botswana OR Brazil OR Brunei Darussalam OR Bulgaria OR Burkina Faso OR Burundi OR Cabo Verde OR Cambodia OR Cameroon OR Central African Republic OR Chad OR China OR Colombia OR Comoros OR Congo OR Costa Rica OR Cote d'Ivoire OR Cuba OR Democratic Republic of the Congo OR Djibouti OR Dominica OR Dominican Republic OR East Timor (Timor-Leste) OR Ecuador OR Egypt OR El Salvador OR Equatorial Guinea OR Eritrea OR Eswatini (Swaziland) OR Ethiopia OR Fiji OR Gabon OR Gambia OR Georgia OR Ghana OR Grenada OR Guatemala OR Guinea OR Guinea-Bissau OR Guyana OR Haiti OR Honduras OR India OR Indonesia OR Iran OR Iraq OR Jamaica OR Jordan OR Kazakhstan OR Kenya OR Kiribati OR Kosovo OR Kyrgyzstan OR Laos OR Lebanon OR Lesotho OR Liberia OR Libya OR Macedonia (North Macedonia) OR Madagascar OR Malawi OR Malaysia OR Maldives OR Mali OR Marshall Islands OR Mauritania OR Mauritius OR Mexico OR Micronesia OR Moldova OR Mongolia OR Montenegro OR Morocco OR Mozambique OR Myanmar (Burma) OR Namibia OR Nepal OR Nicaragua OR Niger OR Nigeria OR Niue OR North Korea OR Pakistan OR Palau OR Papua New Guinea OR Paraguay OR Peru OR Philippines OR Republic of the Congo OR Russia OR Rwanda OR Saint Lucia OR Saint Vincent and the Grenadines OR Samoa OR Sao Tome and Principe OR Senegal OR Serbia OR Sierra Leone OR Solomon Islands OR Somalia OR South Africa OR South Sudan OR Sri Lanka OR Sudan OR Suriname OR Syria OR Tajikistan OR Tanzania OR Thailand OR Togo OR Tonga OR Tunisia OR Turkey OR Turkmenistan OR Tuvalu OR Uganda OR Ukraine OR Uzbekistan OR Vanuatu OR Venezuela OR Vietnam OR West Bank and Gaza OR Yemen OR Zambia OR Zimbabwe)	1668	601
Rotation	("cropping system diversification" OR "crop diversification" OR "diversif* crop*" OR "crop rotation*" OR polycultur* OR "double crop*" OR "triple crop*" OR "relay crop*" OR ("crop succession" OR "crop* sequence") OR (divers* NEAR (farm* OR agric* OR "food system"))) AND ("benefit cost ratio" OR "benefit-cost ratio" OR BCR OR "benefit cost analy*" OR "benefit-cost analy*" OR "bottom line" OR "break even period*" OR "breakeven period*" OR "capital destruction" OR "cost benefit ratio" OR "cost-benefit ratio" OR "cost benefit analy*" OR "cost-benefit analy*" OR "cost effectiv* analy*" OR cost* OR debit* OR "discount* cash flow*" OR "earnings before interest tax" OR "econom* analy*" OR "econom* evaluation*" OR "econom* valuation*" OR "economic impact*" OR expense* OR "full time equivalent*" OR "gross added value*" OR "gross income*" OR "gross margin*" OR income* OR "interest rate*" OR labor* OR labour* OR lease OR "man day*" OR "man power" OR "net added value*" OR "net farm income*" OR "net income*" OR "net present value*" OR "net worth" OR "operating profit*" OR "opportunity cost*" OR "partial budget*" OR "payback period*" OR payment* OR profit* OR receipt* OR return* OR revenue* OR tax OR "turnoff rate*" OR "willingness to pay" OR "working day*" OR (("direct use" OR "direct-use" OR "passive use"OR "passive-use" OR "non market" OR "non-market" OR contingent OR consumptive OR consumption OR subsistence OR livelihood*) AND (value* OR valuation*)) OR financ*) AND (Afghanistan OR Albania OR	3301	1463

	Algeria OR Angola OR Argentina OR Armenia OR Azerbaijan OR Bangladesh OR Belarus OR Belize OR Benin OR Bhutan OR Bolivia OR Bosnia and Herzegovina OR Botswana OR Brazil OR Brunei Darussalam OR Bulgaria OR Burkina Faso OR Burundi OR Cabo Verde OR Cambodia OR Cameroon OR Central African Republic OR Chad OR China OR Colombia OR Comoros OR Congo OR Costa Rica OR Cote d'Ivoire OR Cuba OR Democratic Republic of the Congo OR Djibouti OR Dominica OR Dominican Republic OR East Timor (Timor-Leste) OR Ecuador OR Egypt OR El Salvador OR Equatorial Guinea OR Eritrea OR Eswatini (Swaziland) OR Ethiopia OR Fiji OR Gabon OR Gambia OR Georgia OR Ghana OR Grenada OR Guatemala OR Guinea OR Guinea-Bissau OR Guyana OR Haiti OR Honduras OR India OR Indonesia OR Iran OR Iraq OR Jamaica OR Jordan OR Kazakhstan OR Kenya OR Kiribati OR Kosovo OR Kyrgyzstan OR Laos OR Lebanon OR Lesotho OR Liberia OR Libya OR Macedonia (North Macedonia) OR Madagascar OR Malawi OR Malaysia OR Maldives OR Mali OR Marshall Islands OR Mauritania OR Mauritius OR Mexico OR Micronesia OR Moldova OR Mongolia OR Montenegro OR Morocco OR Mozambique OR Myanmar (Burma) OR Namibia OR Nepal OR Nicaragua OR Niger OR Nigeria OR Niue OR North Korea OR Pakistan OR Palau OR Papua New Guinea OR Paraguay OR Peru OR Philippines OR Republic of the Congo OR Russia OR Rwanda OR Saint Lucia OR Saint Vincent and the Grenadines OR Samoa OR Sao Tome and Principe OR Senegal OR Serbia OR Sierra Leone OR Solomon Islands OR Somalia OR South Africa OR South Sudan OR Sri Lanka OR Sudan OR Suriname OR Syria OR Tajikistan OR Tanzania OR Thailand OR Togo OR Tonga OR Tunisia OR Turkey OR Turkmenistan OR Tuvalu OR Uganda OR Ukraine OR Uzbekistan OR Vanuatu OR Venezuela OR Vietnam OR West Bank and Gaza OR Yemen OR Zambia OR Zimbabwe)		

Table S3 | Studies contributing to the NbS meta-dataset

Code	Article
6132757	Barma, N. C. D.; Bhatt, B. P.; Chattopadhyay, C.; Chowdhury, A. K.; Gathala, Mahesh K.; Gerard, B.; Islam, Md. S.; Jackson, Tamara M.; Laing, Alison M.; Rana, D. S.; Shrestha, R.; Singh, A. K.; Timsina, J.; Tiwari, T. P. | Enabling smallholder farmers to sustainably improve their food, energy and water nexus while achieving environmental and economic benefits| doi: 10.1016/j.rser.2019.109645
6132772	Ferdousi, M. N. S.; Hossain, Akbar; Jahan, M. A. H. S.; Sarkar, M. A. R.; da Silva, Jaime A. Teixeira | Productivity impacts and nutrient balances of an intensive potato-mungbean-rice crop rotation in multiple environments of Bangladesh| doi: 10.1016/j.agee.2016.06.032
6133107	Maliki, Raphiou; Sinsin, Brice; Toukourou, Mouissou; Vernier, Philippe | Productivity of yam-based systems with herbaceous legumes and short fallows in the Guinea-Sudan transition zone of Benin| doi: 10.1007/s10705-011-9468-7
6133126	Assogba, G.; Mensah, R. K.; Monday, P.; Sanfillippo, D.; Vodouhe, D. S. | Increasing organic cotton production in Benin West Africa with a supplementary food spray product to manage pests and beneficial insects| doi: 10.1080/09670874.2011.645905
6133163	Deb, Jiban Chandra; Hickey, Gordon M.; Kayes, Imrul; Rahman, H. M. Tuihedur | Contrasting the financial efficiency of agroforestry practices in buffer zone management of Madhupur National Park, Bangladesh| doi: 10.1007/s10310-013-0392-3
6133167	Bell, Richard W.; Haque, Md Enamul; Islam, Md Ariful; Jahiruddin, M.; Johansen, Chris; Vance, Wendy | Conservation agriculture effects on yield and profitability of rice-based systems in the Eastern Indo-Gangetic Plain| doi: 10.1017/S0014479722000291
6133170	Bell, R. W.; Haque, M. E.; Hossain, M. M.; Hossen, M. A. | Transplanting into non-puddled soils with a small-scale mechanical transplanter reduced fuel, labour, and irrigation water requirements for rice (Oryza sativa L.) establishment and increased yield| doi: 10.1016/j.fcr.2018.06.009
6133174	Goswami, Palash C.; Hossain, Md Faruk; Mahalder, Debabrata; Rashid, M. Harunur; Rony, M. Khairul, I; Russell, Timothy D.; Shirazy, B. J. | Mechanised non-puddled transplanting of boro rice following mustard conserves resources and enhances productivity| doi: 10.1016/j.fcr.2018.06.006
6133181	Alim, Md. Abdul; Arefin, Md. Shamsul; Bhatt, Rajan; Hassan, Mohamed M.; Hassan, Sabry; Hossain, Akbar; Islam, Md. Ariful; Rahman, Md. Mokhlesur; Soliman, Mahmoud F. K. | Integrated Nutrient Management Improves Productivity and Quality of Sugarcane (Saccharum Officinarum L.)| doi: 10.32604/phyton.2022.017359
6133187	Ali, M. Akkas; Hossain, Md Faruque; Islam, Md Aminul; Islam, Md Jahedul; Khan, A. S. M. Mahbubur Rahman; Moniruzzaman, Md | Transforming Triple Cropping System to Four Crops Pattern: An Approach of Enhancing System Productivity through Intensifying Land Use System in Bangladesh| doi: 10.1155/2018/7149835
6133189	Assefa, Yared; Bhandari, Humnath; Bhattacharya, Jayanta; Jagadish, S. V. Krishna; Mondal, Manoranjan K.; Parvin, Rokhsana; Prasad, P. V. Vara; Rahman, Mahabubur; Sarker, Shilpi R.; Shew, Aaron M.; Sutradhar, Asish; Yadav, Sudhir | Crop diversification in rice-based systems in the polders of Bangladesh: Yield stability, profitability, and associated risk| doi: 10.1016/j.agsy.2020.102986
6133198	Borghi, E.; Crusciol, C. A. C.; Martins, P. O.; Mateus, G. P.; Nascente, A. S.; Pariz, C. M. | Intercropping soybean and palisade grass for enhanced land use efficiency and revenue in a no till system| doi: 10.1016/j.eja.2014.05.001
6133205	Perdona, Marcos J.; Soratto, Rogerio P. | Arabica Coffee-Macadamia Intercropping: A Suitable Macadamia Cultivar to Allow Mechanization Practices and Maximize Profi tability| doi: 10.2134/agronj2016.01.0024
6133257	Bossolani, Joao W.; Cantarella, Heitor; Castilhos, Andre M.; Costa, Ciniro; Costa, Claudio H. M.; Costa, Nidia R.; Crusciol, Carlos A. C.; Franzluebbers, Alan J.; Momesso, Letusa; Pariz, Cristiano M.; Portugal, Jose R. | Overcoming Competition From Intercropped Forages on Upland Rice With Optimized Nitrogen Input to Food Production in Tropical Region| doi: 10.3389/fsufs.2020.00129
6133272	Golabi, Mohammad H.; He, Jin; Li, Hongwen; Wang, Qingjie; Zhang, Xirui | Influence of conservation tillage practices on soil properties and crop yields for maize and wheat cultivation in Beijing, China| doi: 10.1071/SR08110
6133277	Chander, Girish; Dar, William D.; Dixin, Yin; Li, Zhong; Wani, Suhas P. | Enhancing agricultural productivity and rural incomes through sustainable use of natural resources in the Semi Arid Tropics| doi: 10.1002/jsfa.4721
6133283	Komarek, Adam M. | Conservation agriculture in western China increases productivity and profits without decreasing resilience| doi: 10.1007/s12571-018-0833-0
6133284	Cui, Song; Li, Juncheng; Li, Zhou; Shen, Yuying; Yang, Qian; Yang, Xianlong; Yang, Xuan | Developing sustainable cropping systems by integrating crop rotation with conservation tillage practices on the Loess Plateau, a long-term imperative| doi: 10.1016/j.fcr.2018.03.027
6133288	Huffman, Ted; Liu, Xiaobing; Yang, Jingyi; Zhang, Shaoliang; Zhang, Xingyi | Soil Loss, Crop Growth, and Economic Margins under Different Management Systems on a Sloping Field in the Black Soil Area of Northeast China| doi: 10.1080/10440046.2011.554307
6133289	Li, Jun; Wang, Hao; Wang, Rui; Wang, Shulan; Wang, Xiaoli; Wen, Pengfei; Yu, Qi | A suitable rotational conservation tillage system ameliorates soil physical properties and wheat yield: An 11-year in-situ study in a semi-arid agroecosystem| doi: 10.1016/j.still.2020.104600

He, J.; Li, H.; Li, W.; Lu, Z.; McHugh, A. D.; Wang, Q.; Zhang, Y. | Permanent raised beds improved crop performance and water use on the North China Plain| doi:
6133293 10.2489/jswc.70.1.54
Li, Feng-Min; Liu, Chang-An; Ma, Bao-Luo; Qiang, Sheng-Cai; Wang, Chun-Ling; Wang, Run-Yuan; Xiong, You-Cai; Zhao, Hong | Ridge-furrow with full plastic film mulching
6133294 improves water use efficiency and tuber yields of potato in a semiarid rainfed ecosystem| doi: 10.1016/j.fcr.2014.02.013
Cai, Liqun; Coulter, Jeffrey A.; Li, Lingling; Luo, Zhuzhu; Palta, Jairo A.; Wang, Linlin; Xie, Junhong; Zhang, Renzhi | Managing the trade-offs among yield, economic benefits and
6133296 carbon and nitrogen footprints of wheat cropping in a semi-arid region of China| doi: 10.1016/j.scitotenv.2021.145280
Changwei, Yu; Dabin, Zhang; Na, Zhao; Pengwei, Yao; Qunhu, Cao; Weidong, Cao; Yajun, Gao; Zheng, Wang | Responses of Winter Wheat Production to Green Manure and
6133303 Nitrogen Fertilizer on the Loess Plateau| doi: 10.2134/agronj14.0432
Hu, Mengjun; Li, Shuo; Shi, Jianglan; Tian, Xiaohong; Wu, Jiechen | Integrated wheat-maize straw and tillage management strategies influence economic profit and carbon
6133363 footprint in the Guanzhong Plain of China| doi: 10.1016/j.scitotenv.2021.145347
He, Cong; Kou, Yi-Hong; Wang, Yu-Qiao; Yu, Wei-Bao; Yves, Bohoussou N'dri; Zhang, Hai-Lin; Zhao, Xin | Comprehensive analysis of resource utilization efficiency under
6133383 different tillage systems in North China Plain| doi: 10.1016/j.jclepro.2022.131289
Chai, Qiang; Fan, Zhilong; Feng, Fuxue; Guo, Yao; Hu, Falong; Yin, Wen; Yu, Aizhong; Zhao, Cai | Wheat-Maize Intercropping With Reduced Tillage and Straw Retention: A Step
6133407 Towards Enhancing Economic and Environmental Benefits in Arid Areas| doi: 10.3389/fpls.2018.01328
Huang, Guanhua; Huang, Quanzhong; Li, Changjian; Qu, Zhongyi; Xiong, Yunwu; Xu, Xu | Impact of biochar addition on soil properties and water-fertilizer productivity of tomato in
6133417 semi-arid region of Inner Mongolia, China| doi: 10.1016/j.geoderma.2018.06.014
Huang, Fangyuan; Jia, Zhikuan; Wu, Yang; Zhang, Chao | Effects of different mulching patterns on soil moisture, temperature, and maize yield in a semi-arid region of the Loess
6133477 Plateau, China| doi: 10.1080/15324982.2016.1194911
Li, Changjiang; Li, Shuo | Energy budget and carbon footprint in a wheat and maize system under ridge furrow strategy in dry semi humid areas| doi: 10.1038/s41598-021-
6133479 88717-3
Li, Haoyu; Li, Jun; Liu, Pengzhao; Sun, Yuanguang; Wang, Rui; Wang, Xiaoli; Zhang, Qi; Zhang, Yuanhong | Long-term effects of optimized fertilization, tillage and crop rotation on
6133498 soil fertility, crop yield and economic profit on the Loess Plateau| doi: 10.1016/j.eja.2022.126731
Cui, Yong; Liao, Yuncheng; Lu, Xingli; Lu, Xingneng | Tillage and crop straw methods affect energy use efficiency, economics, and greenhouse gas emissions in rainfed winter
6133555 wheat field of Loess Plateau in China| doi: 10.1080/09064710.2018.1448883
Tian, Yuhua; Yao, Yuanlin; Yin, Bin; Zeng, Ke; Zhang, Bowen; Zhang, Min; Zhao, Meng; Zhao, Miao | Duckweed (Spirodela polyrhiza) as green manure for increasing yield and
6133557 reducing nitrogen loss in rice production| doi: 10.1016/j.fcr.2017.09.021
Chen, Yanling; Mi, Guohua; Shao, Hui; Sokolowski, Eldad; Wu, Dali; Xu, Xinxing | Effect of different drip fertigation methods on maize yield, nutrient and water productivity in two-
6133761 soils in Northeast China| doi: 10.1016/j.agwat.2018.10.018
Feng, Gary; Jia, Yonglin; Ma, Chao; Qu, Zhongyi; Yang, Wei | Residual effect of single biochar application on soil nutrients availability and fertilizer productivity in a mulched drip-
6133864 irrigated corn field| doi: 10.1080/03650340.2022.2045280
Fan, Junliang; Guo, Jinjin; Lai, Zhenlin; Li, Zhijun; Liao, Zhenqi; Xiang, Youzhen; Yan, Shicheng; Zhang, Fucang; Zheng, Jing; Zhou, Minghua | Ridge-furrow plastic film mulching
enhances grain yield and yield stability of rainfed maize by improving resources capture and use efficiency in a semi-humid drought-prone region| doi:
6133911 10.1016/j.agwat.2022.107654
Guo, Wen-zhong; Li, Yin-kun; Ma, Li; Wang, Li-chun; Wang, Zhan; Xu, Zhi-gang | Yield, nitrogen use efficiency and economic benefits of biochar additions to Chinese Flowering
6133912 Cabbage in Northwest China| doi: 10.1007/s10705-019-09971-6
6133913 Li, Zizhong; Sun, Tao | Alfalfa-corn rotation and row placement affects yield, water use, and economic returns in Northeast China| doi: 10.1016/j.fcr.2019.107558
Ahmad, N.; Akram, A.; Artiola, Janick F.; Qazi, M. Akram; Tuller, M. | Economical and environmental implications of solid waste compost applications to agricultural fields in
6133957 Punjab, Pakistan| doi: 10.1016/j.wasman.2009.05.006
Cheng, Mao; Gan, Shuxian; Hu, Fengyi; Hu, Jian; Huang, Guangfu; Huang, Liyu; Zhang, Jing; Zhang, Shilai; Zhang, Yujiao | An innovated crop management scheme for perennial
6133966 rice cropping system and its impacts on sustainable rice production| doi: 10.1016/j.eja.2020.126186
Gang, Xue; Huabing, Liu; Shixiao, Xu; Tiezhao, Yang; Xi, Yueling; Yufu, Peng | Plastic film mulching combined with nutrient management to improve water use efficiency,
6134005 production of rain-fed maize and economic returns in semi-arid regions| doi: 10.1016/j.fcr.2018.11.010
Li, L-H; Shen, L.; Wan, S-M; Wang, X-Y; Yang, T.; Zhang, W-L; Zhang, W. | Formation of factors influencing cotton yield in jujube-cotton intercropping systems in Xinjiang, China|
6134030 doi: 10.1007/s10457-020-00571-w
Li, Shuo; Ma, Lin; Wang, Xiaoqin; Wu, Jiechen | Economic and environmental sustainability of maize-wheat rotation production when substituting mineral fertilizers with manure
6134071 in the North China Plain| doi: 10.1016/j.jclepro.2020.122683
Cao, Guojun; Geng, Yuhui; Huang, Jinxin; Wang, Lichun; Wang, Meng | Can drip irrigation under mulch be replaced with shallow-buried drip irrigation in spring maize production
6134085 systems in semiarid areas of northern China?| doi: 10.1002/jsfa.10808

Li, Shuo; Shi, Jianglan; Tian, Xiaohong; Wang, Shujuan; Wu, Jiechen | Economic, energy and environmental performance assessment on wheat production under water-saving
6134105 cultivation strategies| doi: 10.1016/j.energy.2022.125330
Cui, Rongzong; He, Ping; Qiu, Shaojun; Sun, Jingxia; Wei, Jianlin; Xu, Xinpeng; Zhao, Shicheng; Zhou, Wei | Use of Controlled-Release Urea to Improve Yield, Nitrogen Utilization,
6134172 and Economic Return and Reduce Nitrogen Loss in Wheat-Maize Crop Rotations| doi: 10.3390/agronomy11040723
Chen, Juan; Geng, Zhiguang; Li, Feng; Li, Kefu; Siddique, Kadambot H. M.; Song, Yali; Zhang, Guohong | Straw mulching for enhanced water use efficiency and economic returns
6134190 from soybean fields in the Loess Plateau China| doi: 10.1038/s41598-022-21141-3
Cao, Tiehua; Deng, Aixing; Feng, Xiaomin; Guo, Jinrui; Lal, Rattan; Song, Zhenwei; Sun, Tao; Zhang, Jun; Zhang, Weijian; Zheng, Chengyan | Crop diversification practice faces a
6134193 tradeoff between increasing productivity and reducing carbon footprints| doi: 10.1016/j.agee.2021.107614
Chen, Yijie; Dang, Pengfei; Han, Xiaoqing; Qin, Xiaoliang; Siddique, Kadambot H. M.; Wang, Hongyu; Zhang, Miaomiao | Decreased carbon footprint and increased grain yield under
6134226 ridge-furrow plastic film mulch with ditch-buried straw returning: A sustainable option for spring maize production in China| doi: 10.1016/j.scitotenv.2022.156412
Cui, Ningbo; Fan, Junliang; Guo, Jinjin; Guo, Li; Yan, Shicheng; Zhang, Fucang; Zheng, Jing; Zhuang, Qianlai | Interactive effects of mulching practice and nitrogen rate on grain
6134244 yield, water productivity, fertilizer use efficiency and greenhouse gas emissions of rainfed summer maize in northwest China| doi: 10.1016/j.agwat.2021.106778
Fan, Zhiyao; Guo, Yuxin; Hao, Xinru; Hu, Xiao; Ma, Jianhui; Wu, Lin; Zhang, Daijing | Optimizing Tillage and Fertilization Patterns to Improve Soil Physical Properties, NUE and
6134254 Economic Benefits of Wheat-Maize Crop Rotation Systems| doi: 10.3390/agriculture12081264
Ashraf, Umair; Duan, Meiyang; Li, Lin; Mo, Zhaowen; Pan, Shenggang; Tang, Xiangru; Tian, Hua; Wang, Zaiman; Wu, Tiaoyan; Zhang, Zheng | Productivity and profitability of
6134311 mechanized deep nitrogen fertilization in mechanical pot-seedling transplanting rice in South China| doi: 10.1002/agj2.20564
Gao, Na; Li, Shiqing; Shen, Yufang; Wei, Yanan; Yang, Bin; Yue, Shanchao; Zhang, WeiWei | Carbon footprint, yield and economic performance assessment of different mulching
6134327 strategies in a semi-arid spring maize system| doi: 10.1016/j.scitotenv.2022.154021
Kong, Yuanyuan; Liu, Zhiming; Lyu, Yanjie; Shao, Xiwen; Wang, Yongjun; Zhang, Xiaolong | Deep Tillage Improves the Grain Yield and Nitrogen Use Efficiency of Maize (Zea mays
6134332 L.) Under a Wide-Narrow Row Alternative System in Northeast China| doi: 10.1007/s42106-021-00181-1
Li, Luhua; Liu, Tingting; Shen, Lei; Tuerti, Tayir; Wang, Xiuyuan; Wei, Wenwen; Zhang, Shuai; Zhang, Wei | Juvenile plumcot tree can improve fruit quality and economic benefits
6134448 by intercropping with alfalfa in semi-arid areas| doi: 10.1016/j.agsy.2022.103590
Gou, Jiulan; Gu, Xiaofeng; Liu, Lingling; Liu, Yanling; Wei, Quanquan; Zhang, Meng | Biochar-Based Fertilizer Enhances the Production Capacity and Economic Benefit of Open-
6134498 Field Eggplant in the Karst Region of Southwest China| doi: 10.3390/agriculture12091388
Chen, Tao; Deng, Aixing; Qi, Yongkui; Shang, Ziyin; Song, Zhenwei; Wang, Tianshu; Yang, Ruiping; Zhang, Jun; Zhang, Weijian; Zhang, Xin; Zheng, Chengyan | Optimization of Rice-
6134554 Based Double-Cropping System with Conservation Practice Mitigates Carbon Emission While Ensuring Profitability| doi: 10.3390/agronomy12040924
Chen, Haixin; Chu, Xiaosheng; Feng, Hao; Li, Cheng; Lin, Nanping; Luo, Xiaoqi; Wang, Naijiang | Plastic film-mulched ridges and straw-mulched furrows increase soil carbon
6134662 sequestration and net ecosystem economic benefit in a wheat-maize rotation| doi: 10.1016/j.agee.2022.108311
Alayon-Gamboa, Armando; Jimenez-Ferrer, Guillermo; Mendoza-Martinez, German; Soto-Pinto, Lorena | Evaluation of local energy sources in milk production in a tropical
6134671 silvopastoral system with Erythrina poeppigiana| doi: 10.1007/s11250-015-0806-7
Dhehibi, Boubaker; Laouar, Abdelmalek; Mekhlouk, Abdelhamid; Rouabhi, Amar | Socioeconomic assessment of no-till in wheat cropping system: a case study in Algeria| doi:
6135226 10.30682/nm1901e
Alwang, J. R.; Cartagena Ayala, Y. E.; D'Adamo, R.; Delgado, J. A.; Dominguez Andrade, J. M.; Escudero Lopez, L. O.; Mosquera, V. H. Barrera | Conservation Agriculture Increases
6135391 Yields and Economic Returns of Potato, Forage, and Grain Systems of the Andes| doi: 10.2134/agronj2019.04.0280
Alwang, J.; Barrowclough, M.; Dominguez, J. M.; Gallagher, R.; Mosquera, V. H. Barrera; Stehouwer, R. | Conservation agriculture on steep slopes in the Andes: Promise and
6135418 obstacles| doi: 10.2489/jswc.71.2.91

6135431 Perez Neira, David | Energy efficiency of cacao agroforestry under traditional and organic management| doi: 10.1007/s13593-016-0386-6
Alamery, Salman; Das, Shobhan; El-Kholy, Mohamed Farouk; Hassan, Khairy H. A.; Salem-Bekhit, Mounir M. | Effect of Some Soil Conditioners on Water-Use Efficacy, Growth,
6135532 and Yield of Date Palm Siwi Grown in Sandy Soil under Different Irrigation Regimes to Mitigate Climate Change| doi: 10.3390/su141811421
Awad, Mohamed F.; Datta, Avishek; El-KHOLY, Ahmed S. M.; El-sobky, El-Sayed E. A.; Hassan, Hend H. M.; Mansour, Elsayed; Ullah, Hayat | Influence of preceding crop and
6135575 tillage system on forage yield and quality of selected summer grass and legume forage crops under arid conditions| doi: 10.1016/j.jia.2022.08.088
Aragaw, K.; Ayalew, W.; Malmfors, B.; Nasholm, A.; Philipsson, J.; Rege, J. E. O.; Tibbo, M. | A field trial of production and financial consequences of helminthosis control in sheep
6135587 production in Ethiopia| doi: 10.1016/j.prevetmed.2007.12.011
Aune, Jens B.; Johnsen, Fred H.; Tulema, Balesh; Vanlauwe, Bernard | The prospects of reduced tillage in tef (Eragrostis tef Zucca) in Gare Arera, West Shawa Zone of Oromiya,
6135613 Ethiopia| doi: 10.1016/j.still.2007.12.001
Bayu, Wondimu; Demelash, Nigus; Sommer, Rolf; Tesfaye, Sitot; Ziadat, Feras | Current and residual effects of compost and inorganic fertilizer on wheat and soil chemical
6135638 properties| doi: 10.1007/s10705-014-9654-5

Abera, Dejene; Ashraf, Muhammad; Ayana, Getachew; Gao, Ben-Qiang; Li, Feng-Min; Wang, Bin-Xian; Yuan, Zi-Qiang; Zhang, Rong | Film mulch with irrigation and rainfed
6135654 cultivations improves maize production and water use efficiency in Ethiopia| doi: 10.1111/aab.12531
Adie, Abera; Barron, Jennie; Blummel, Michael; Fenta, Habtamu M.; Hussein, Misbah A.; Nakawuka, Prossie; Schmitter, Petra; Steenhuis, Tammo S.; Tilahun, Seifu A. | Berken
6135658 plow and intercropping with pigeon pea ameliorate degraded soils with a hardpan in the Ethiopian highlands| doi: 10.1016/j.geoderma.2021.115523
Desta, Bizuwork Tafes; Gezahegn, Almaz Meseret; Tesema, Sisay Eshetu | Impacts of tillage practice on the productivity of durum wheat in Ethiopia| doi:
6135671 10.1080/23311932.2020.1869382
Alemayehu, Getachew; Ayalew, Dereje; Hunegnaw, Yirsaw; Kassaye, Mulatu | Plant Density and Time of White Lupine (Lupinus Albus L.) Relay Cropping with Tef (Eragrostis tef
6135783 (Zucc.) Trotter) in Additive Design in the Highlands of Northwest Ethiopia| doi: 10.1155/2022/8730191
Abate, Asefa; Alemayehu, Getachew | Influence of integrated soil fertilization on the productivity and economic return of garlic (Allium sativum L.) and soil fertility in northwest
6135786 Ethiopian highlands| doi: 10.1515/opag-2021-0047
Damte, Matebe; Ejigu, Workineh; Elias, Eyasu; Selassie, Yihenew G. | Integrated fertilizer application improves soil properties and maize (Zea mays L.) yield on Nitisols in
6135798 Northwestern Ethiopia| doi: 10.1016/j.heliyon.2021.e06074
Adgo, Enyew; Ebabu, Kindiye; Haregeweyn, Nigussie; Masunaga, Tsugiyuki; Meshesha, Derege Tsegaye; Mihretie, Fekremariam Asargew; Tassew, Asamenew; Tsubo, Mitsuru;
Tsuji, Wataru; Tsunekawa, Atsushi | Tillage and sowing options for enhancing productivity and profitability of teff in a sub-tropical highland environment| doi:
6135817 10.1016/j.fcr.2020.108050
Adgo, Enyew; Berihun, Mulatu Liyew; Demissie, Simeneh; Ebabu, Kindiye; Fekadu, Genetu; Haregeweyn, Nigussie; Kebede, Birhanu; Masunaga, Tsugiyuki; Meshesha, Derege
Tsegaye; Mulualem, Temesgen; Tsubo, Mitsuru; Tsunekawa, Atsushi; Wubet, Anteneh | Dual benefits of polyacrylamide and other soil amendments: Mitigation of soil nutrient
6135851 depletion and improvement of use-efficiency in midland agro-ecology, Ethiopia| doi: 10.1002/ldr.4367
Ejigu, Workineh; Elias, Eyasu; Selassie, Yihenew G.; Smaling, Eric | Effect of integrated fertilizer application on soil properties and tef (Eragrostis tef [Zucc] Trotter) yield on
6135863 Vertisols of Northwestern Ethiopia| doi: 10.1080/01904167.2021.1985140
Alemayehu Damot, Getachew; Ayalew Zewdie, Dereje; Gebremedhin Woldemariam, Zenebe | Nitrogen fertilizer and cattle manure for Striga (Striga hermonthica) management
6135971 and enhancement of sorghum productivity in northwest Ethiopia| doi: 10.1080/01904167.2021.1952219
Chipindu, Lovemore; Kassa, Abrham; Mhlanga, Blessing; Mupangwa, Walter; Mutenje, Munyaradzi; Ncube, Bongani; Tadesse, Ephrem; Yahaya, Rabe | Crop Productivity,
6136220 Nutritional and Economic Benefits of No-Till Systems in Smallholder Farms of Ethiopia| doi: 10.3390/agronomy13010115
Asefa, Fayera; Hasan, Mohammad Najmus Saquib; Hunduma, Adugna; Nandeshwar, B. C.; Tufa, Abdela | Levels of Biochar and NPS Fertilizer Rates on Growth, Yield Component,
6136256 and Yield of Maize (Zea mays L.) at Guto Gida, Western Ethiopia| doi: 10.1155/2022/5400431
Abdulkadir, Birhan; Admasu, Almaz; Admasu, Wubengeda; Debebe, Anbessie; Habte, Dawit; Mekonnen, Asrat; Tadesse, Amare; Tadesse, Kassu | Effects of seeding and nitrogen
6136322 fertilizer rates on malting barley yield and quality in highland tropical environment| doi: 10.1016/j.jagp.2022.04.014
Dogbe, W; Langyintuo, AS; Lowenberg-Deboer, J; Yiridoe, EK | Yield and income risk-efficiency analysis of alternative systems for rice production in the Guinea Savannah of
6136349 Northern Ghana| doi: 10.1111/j.0169-5150.2005.00013.x
Bright, Geoff; Cobbina, Joseph; Jatango, John Ayisi; McDonald, Morag; Obiri, Beatrice Darko; Sinclair, Fergus | The economic potential and farmer perceptions of herbaceous
6136388 legume fallows in Ghana| doi: 10.1017/S0014479707005005
Adiku, Samuel G. K.; Darko, Eric; MacCarthy, Dilys S.; Nartey, Eric K.; Tettey, Abigail | Integrating Biochar and Inorganic Fertilizer Improves Productivity and Profitability of
6136396 Irrigated Rice in Ghana, West Africa| doi: 10.3390/agronomy10060904
Abaidoo, Robert C.; Adjei-Nsiah, Samuel; Ahiabor, Benjamin D. K.; Franke, Angelinus C.; Giller, Ken E.; Kermah, Michael | Maize-grain legume intercropping for enhanced
6136416 resource use efficiency and crop productivity in the Guinea savanna of northern Ghana| doi: 10.1016/j.fcr.2017.07.008
Abdul Rahman, Nurudeen; Akakpo, Daniel Brain; Asante, Mary Otiwaa; Hoeschle-Zeledon, Irmgard; Kotu, Bekele; Larbi, Asamoah; Mellon-Bedi, Shaibu | Maize-legume strip
6136553 cropping effect on productivity, income, and income risk of farmers in northern Ghana| doi: 10.1002/agj2.20536
Bashagaluke, Janvier Bigabwa; Logah, Vincent; Opoku, Andrews; Sakordie-Addo, Joseph | Nutrient uptake and productivity of four tropical cropping systems under biochar
6136571 amendment| doi: 10.1002/agj2.20259
Calderon, Claudia Irene; Hogan, Rose; Jeronimo, Claudia; Leon, Raquel; Prado Cordova, Jose Pablo; Praun, Alexandra; Reyna, Jaime; Santos Castillo, Ivan Dimitri | Agroecology-
6136634 based farming provides grounds for more resilient livelihoods among smallholders in Western Guatemala| doi: 10.1080/21683565.2018.1489933
6136635 Adams, JF; Bossa, JR; Mullins, GL; Shannon, DA; van Santen, E | Phosphorus, potassium and leucaena pruning interactions on corn in Haiti| doi: 10.1007/s10705-005-7128-5
Anten, Niels P. R.; Craufurd, P. Q.; Kropff, M. J.; Meinke, H.; Parsons, D.; Rao, V. Nageswara; Rego, T. J.; Wani, S. P. | Strategic double cropping on Vertisols: A viable rainfed
6136928 cropping option in the Indian SAT to increase productivity and reduce risk| doi: 10.1016/j.eja.2014.09.003
Behera, U. K.; Pandey, H. N.; Sharma, A. R. | Sustaining productivity of wheat-soybean cropping system through integrated nutrient management practices on the Vertisols of
6136932 central India| doi: 10.1007/s11104-007-9332-3

Bandyopadhyay, KK; Ghosh, PK; Hati, KM; Mandal, KG; Misra, AK; Saha, KP; Singh, VV | Cropping systems of Central India: An energy and economic analysis| doi:
6136941 10.1300/J064v25n03_08

6136942 Ghosh, A. | Integrated Nutrient Management by Using Target Yield Equations for Rice-Jute System in Eastern India| doi: 10.1080/10440040802121528

Gathala, M. K.; Gupta, Raj; Jat, M. L.; Saharawat, Y. S.; Tetarwal, J. P.; Yadvinder-Singh | Double no-till and permanent raised beds in maize-wheat rotation of north-western
6136990 Indo-Gangetic plains of India: Effects on crop yields, water productivity, profitability, and soil physical properties| doi: 10.1016/j.fcr.2013.04.024

Arvadia, M. K.; Dungrani, R. A.; Jat, Ram A.; Sahrawat, Kanwar L. | Diversification of rice (Oryza sativa L.)-based cropping systems for higher productivity, resource-use
6137000 efficiency and economic returns in south Gujarat, India| doi: 10.1080/03650340.2010.533172

Kler, D. S.; Ram, Hari; Saini, K. S.; Singh, Yadvinder; Timsina, J. | TILLAGE AND PLANTING METHODS EFFECTS ON YIELD, WATER USE EFFICIENCY AND PROFITABILITY OF
6137001 SOYBEAN-WHEAT SYSTEM ON A LOAMY SAND SOIL| doi:

Abrol, Vikas; Sharma, Peeyush; Sharma, R. K. | Impact of tillage and mulch management on economics, energy requirement and crop performance in maize-wheat rotation in
6137005 rainfed subhumid inceptisols, India| doi: 10.1016/j.eja.2010.10.003

Banik, Pabitra; Sharma, Ravi Chandra | Baby Corn-Legumes Intercropping Systems: I. Yields, Resource Utilization Efficiency, and Soil Health| doi:
6137055 10.1080/21683565.2014.942764

Bijarniya, Deepak; Gupta, Raj K.; Jat, M. K.; Jat, M. L.; Jat, R. K.; Kakraliya, S. K.; Kumar, Mukesh; Parihar, C. M.; Parihar, M. D.; Singh, Ravi G.; Sutaliya, J. M. | Ten years of
6137083 conservation agriculture in a rice-maize rotation of Eastern Gangetic Plains of India: Yield trends, water productivity and economic profitability| doi: 10.1016/j.fcr.2018.12.004

Choudhary, M.; Gathala, M. K.; Jat, H. S.; Jat, M. L.; Sharma, D. K.; Singh, Gurbachan; Singh, Ranbir | Management influence on maize-wheat system performance, water
6137527 productivity and soil biology| doi: 10.1111/sum.12208

Bhatt, B. P.; Humphreys, E.; Idris, M.; Ladha, J. K.; Laik, Ranjan; Saharawat, Yashpal; Sharma, Sheetal; Singh, A. K.; Singh, S. S. | Integration of conservation agriculture with best
6137582 management practices for improving system performance of the rice-wheat rotation in the Eastern Indo-Gangetic Plains of India| doi: 10.1016/j.agee.2014.06.001

Choudhary, V. K.; Kumar, P. Suresh | Crop and water productivity, profitability and energy consumption pattern of a maize-based crop sequence in the North Eastern Himalayan
6137591 Region, India| doi: 10.1080/03650340.2012.665992

Gathala, Mahesh K.; Ghosh, Anup K.; Harun-Ar-Rashid, Md.; Hossain, Md. Israil; Islam, Md. Saiful; Krupnik, Timothy J.; McDonald, Andrew; Rahman, Md. Mahbubur; Timsina,
Jagadish; Tiwari, Thakur P. | Conservation agriculture based tillage and crop establishment options can maintain farmers' yields and increase profits in South Asia's rice-maize
6137700 systems: Evidence from Bangladesh| doi: 10.1016/j.fcr.2014.12.003

Gill, Gurjeet; Malik, Ram K.; Vats, Anil Kumar; Yadav, Ashok; Yadav, Dharam Bir | Direct seeded rice in sequence with zero-tillage wheat in north-western India: addressing
6137772 system-based sustainability issues| doi: 10.1007/s42452-021-04827-7

Jat, M. L.; Jat, S. L.; Kumar, Rakesh; Kuri, B. R.; Parihar, C. M.; Parihar, M. D.; Singh, A. K.; Verma, A. P.; Yadav, Brijesh; Yadav, M. R.; Yadav, R. K. | Long term effect of legume
intensified crop rotations and tillage practices on productivity and profitability of maize vis-a-vis soil fertility in North-Western Indo-Gangetic Plains of India| doi:
6137872 10.18805/1r.v0i0.7583

Dadhwal, K. S.; Ghosh, B. N.; Mishra, P. K.; Patra, Sridhar; Sharma, N. K.; Singh, Raman Jeet | Energy budgeting and emergy synthesis of rainfed maize-wheat rotation system
6137948 with different soil amendment applications| doi: 10.1016/j.ecolind.2015.10.026

Balwinder-Singh; Gathala, Mahesh K.; Jat, Hanuman S.; Kamboj, Baldev R.; Kumar, Virender; Ladha, Jagdish K.; Malik, Ram K.; McDonald, Andrew; Raman, Anitha; Sharma, D. K.;
Sharma, Parbodh C.; Yadav, Arvind K. | Can productivity and profitability be enhanced in intensively managed cereal systems while reducing the environmental footprint of
6141491 production? Assessing sustainable intensification options in the breadbasket of India| doi: 10.1016/j.agee.2017.10.006

Bandyopadhyay, K. K.; Bhattacharyya, Ranjan; Das, T. K.; Jat, M. L.; Saharawat, Y. S.; Sharma, A. R.; Sudhishri, S. | Conservation agriculture effects on crop and water
6141493 productivity, profitability and soil organic carbon accumulation under a maize-wheat cropping system in the North-western Indo-Gangetic Plains| doi: 10.1016/j.fcr.2017.10.021

Choudhary, O. P.; Neemisha; Sharma, Sandeep; Singh, Pritpal | Nitrogen and rice straw incorporation impact nitrogen use efficiency, soil nitrogen pools and enzyme activity in
6141501 rice-wheat system in north-western India| doi: 10.1016/j.fcr.2021.108131

Babu, Subhash; Das, Anup; Datta, Mrinmoy; Lal, Rattan; Meena, Ram Swaroop; Patil, Somanagouda B.; Saha, Poulami; Yadav, Gulab Singh | Conservation tillage and mulching
effects on the adaptive capacity of direct-seeded upland rice (Oryza sativa L.) to alleviate weed and moisture stresses in the North Eastern Himalayan Region of India| doi:
6141505 10.1080/03650340.2018.1423555

Baishya, Lohit K.; Batabyal, Kaushik; Bhuvaneswari, S.; Das, Ruma; Meitei, Ch Bungbungcha; Naorem, Gulleibi Chanu; Padhan, Dhaneshwar; Prakash, Narendra; Rahman, Feroze
H.; Sarkar, Dibyendu; Singh, Jogendra; Thokchom, Repahini Chanu | Can sustainability of maize-mustard cropping system be achieved through balanced nutrient management?|
6141509 doi: 10.1016/j.fcr.2018.05.018

Felix, K. Thomas; Malaiarasan, Umanath; Paramasivam, R. | Crop diversification: determinants and effects under paddy-dominated cropping system| doi: 10.1007/s10333-021-
6141510 00843-w

Aggarwal, Pramila; Bana, R. S.; Bandyopadhyay, K. K.; Bhatia, A.; Bhattacharyya, Ranjan; Das, T. K.; Datta, S. P.; Jat, M. L.; Kar, A.; Pathak, H.; Saharawat, Y. S.; Sepat, Seema; Sharma, A. R.; Sharma, R. K.; Singh, Billu; Singh, Geeta; Singh, Parmendra; Sudhishri, S.; Vyas, A. K. | Conservation agriculture in an irrigated cotton-wheat system of the
6141519 western Indo-Gangetic Plains: Crop and water productivity and economic profitability| doi: 10.1016/j.fcr.2013.12.017
Gupta, Chandra; Gupta, Sanjiv; Pathak, A. D.; Patnaik, J. R.; Sah, A. K.; Singh, S. N.; Singh, V. K.; Tripathi, M. K. | Enhancing Crop Productivity and Profitability of Autumn
6141520 Sugarcane with Intercropping of Winter Vegetables in Real Farming Situations of North-Central India| doi: 10.1007/s12355-022-01219-y
Sharma, Sandeep; Sidhu, H. S.; Singh, Vicky; Thind, H. S.; Yadvinder-Singh | Tillage, crop establishment and residue retention methods for optimising productivity and
6141521 profitability under rice-wheat system| doi: 10.1071/CP21595
Sharma, Sandeep; Sidhu, H. S.; Singh, Yadvinder; Thind, Harmit Singh | Rice-wheat productivity and profitability with residue, tillage, and green manure management| doi:
6141522 10.1007/s10705-018-09967-8
Baghel, J. K.; Bhattacharyya, Ranjan; Das, T. K.; Ghosh, Sourav; Mukherjee, I; Nath, C. P.; Pankaj; Raj, Rishi | Impacts of conservation agriculture and herbicides on weeds,
6141523 nematodes, herbicide residue and productivity in direct-seeded rice| doi: 10.1016/j.still.2020.104634
Hazra, K. K.; Kumar, V; Malik, R. K.; Nandan, Rajiv; Nath, C. P.; Poonia, S. P.; Singh, S. S.; Singh, V; Solanki, Ch Hemant | Crop establishment with conservation tillage and crop
6141524 residue retention in rice-based cropping systems of Eastern India: yield advantage and economic benefit| doi: 10.1007/s10333-018-0641-3
Choudhary, Rakesh; Jat, H. S.; Jat, M. L.; Nandal, D. P.; Sidhu, H. S.; Singh, Parvinder; Yadvinder-Singh | Evaluation of tillage and crop establishment methods integrated with
6141530 relay seeding, of wheat and mungbean for sustainable intensification of cotton-wheat system in South Asia| doi: 10.1016/j.fcr.2016.08.011
Bana, R. S.; Choudhary, G. L.; Prajapat, K.; Rana, K. S. | Moisture conservation and zinc fertilization impacts on quality, profitability and moisture use indices of chickpea (Cicer
6141541 Arietinum L.) under limited moisture conditions| doi: 10.18805/lr.v0iOF.9560
Byju, Gangadharan; Jyothi, Alummottil N.; Sreekumar, Janardanan; Suja, Girija; Veena, Syamala S. | Weed cloth, an option for integrated weed management for short-duration
6141542 cassava| doi: 10.1002/agj2.20528
Babu, Subhash; Das, Anup; Datta, Mrinmoy; Lal, Rattan; Meena, Ram Swaroop; Saha, Poulami; Singh, Raghavendra; Yadav, Gulab Singh | Energy budget and carbon footprint in a
6141551 no-till and mulch based rice mustard cropping system| doi: 10.1016/j.jclepro.2018.04.173
Adhikary, Saju; Bhowmick, Udayan Rudra; Biswas, Benukar; Chakraborty, Debashis; Dhara, Pratap Kumar; Ghosh (Lkn), Dipak Kumar; Kanthal, Sahely; Mondal, Mousumi; Parsad, Rajender; Patra, Kiranmay; Ray, Bikash Ranjan; Sarkar, Arindam; Sarkar, Sukamal; Timsina, Jagadish | Agroforestry offers multiple ecosystem services in degraded
6141553 lateritic soils| doi: 10.1016/j.jclepro.2022.132768
Avasthe, R. K.; Babu, Subhash; Chandra, Puran; Das, Anup; Kumar, Amit; Mohapatra, K. P.; Rathore, S. S.; Singh, Raghavendra; Singh, Vinod K.; Yadav, Gulab Singh | Impact of
6141557 land configuration and organic nutrient management on productivity, quality, and soil properties under baby corn in Eastern Himalayas| doi: 10.1038/s41598-020-73072-6
Choudhary, K. M.; Jat, H. S.; Jat, M. L.; Nandal, D. P.; Poonia, Tanuja; Sharma, P. C.; Singh, Yadvinder; Yadav, A. K. | Conservation Agriculture-based Sustainable Intensification of
6141558 Cereal Systems Leads to Energy Conservation, Higher Productivity and Farm Profitability| doi: 10.1007/s00267-020-01273-w
Bana, Anil; Choudhary, K. M.; Jat, H. S.; Jat, M. L.; Jat, R. D.; Kakraliya, S. K.; Nanwal, R. K.; Sapkota, Tek B.; Sutaliya, J. M.; Yadav, A. K. | Conservation agriculture and precision
6141561 nutrient management practices in maize-wheat system: Effects on crop and water productivity and economic profitability| doi: 10.1016/j.fcr.2018.03.025
Bijarniya, Deepak; Jat, M. L.; Jat, R. K.; Kakraliya, S. K.; Kalvania, Kailash; Parihar, C. M. | Portfolios of Climate Smart Agriculture Practices in Smallholder Rice-Wheat System of
6141562 Eastern Indo-Gangetic Plains-Crop Productivity, Resource Use Efficiency and Environmental Foot Prints| doi: 10.3390/agronomy10101561
Bana, R. S.; Biswakarma, Niraj; Choudhary, A. K.; Das, Kajal; Jat, R. D.; Kumar, Dinesh; Lama, Achal; Meena, M. C.; Pal, Madan; Pooniya, Vijay; Shivay, Y. S.; Sudhishri, Susama; Swarnalakshmi, Karivaradharajan; Verma, A. K.; Zhiipao, R. R. | Five years integrated crop management in direct seeded rice-zero till wheat rotation of north-western India:
6141576 Effects on soil carbon dynamics, crop yields, water productivity and economic profitability| doi: 10.1016/j.agee.2021.107492
Borah, T. R.; Chatterjee, Dibyendu; Chowdhury, Pulakabha; Deka, Bidyut C.; Kumar, Rakesh; Kuotsu, Rukuosietuo; Patra, M. K.; Pongen, Imliakum; Ray, Sanjay Kumar; Satapathy,
6141577 B. S.; Thirugnanavel, A. | Preventing soil degradation in shifting cultivation using integrated farming system models| doi: 10.1080/03650340.2021.1937139
Bhardwaj, Seema; Bhaskar, Suryanarayan; Kumar, Mahesh; Kumar, Praveen; Lal, Banwari; Nathawat, Narayan Singh; Rathore, Vijay Singh; Reager, Madan Lal; Santra, Priyabrata; Shekhawat, Ravindra Singh; Singh, Jai Prakash; Yadav, Bhagirath Mal; Yadav, Om Parkash; Yadav, Shish Ram; Yadava, Narendra Dev | Alternative cropping systems
6141580 and optimized management practices for saving groundwater and enhancing economic and environmental sustainability| doi: 10.1016/j.agwat.2022.107840
Abdallah, Ahmed M.; Choudhary, M.; Jat, M. L.; Jat, S. L.; Mahala, D. M.; Meena, B. R.; Nayak, Hari Sankar; Parihar, C. M.; Patra, K.; Patra, S.; Rathi, N.; Rupesh; Sena, D. R.; Sharma, D. K.; Singh, Raj | Co-implementation of precision nutrient management in long-term conservation agriculture-based systems: A step towards sustainable energy-
6141584 water-food nexus| doi: 10.1016/j.energy.2022.124243
Banjara, Tej Ram; Bohra, J. S.; Kumar, Sushil; Pal, Vijay; Ram, Asha | Diversification of Rice-wheat Cropping System Improves Growth, Productivity and Energetics of Rice in the
6141585 Indo-Gangetic Plains of India| doi: 10.1007/s40003-020-00533-9
Bijarniya, Deepak; Gora, M. K.; Jat, H. S.; Jat, M. L.; Kakraliya, Manish; Kakraliya, S. K.; Sharma, P. C.; Singh, Ishwar | Energy and economic efficiency of climate-smart
6141586 agriculture practices in a rice-wheat cropping system of India| doi: 10.1038/s41598-022-12686-4

Bastia, Dilip Kumar; Behera, Subrat Kumar; Panda, Manas Ranjan | Impacts of soil fertility management on productivity and economics of rice and fodder intercropping systems
6141588 under rainfed conditions in Odisha, India| doi: 10.1016/S2095-3119(20)63591-2
Singh, Sudhir; Singh, Y. P.; Tomar, Sandeep S. | Effect of precise levelling, tillage, and seed sowing methods of pearlmillet based cropping systems on productivity and soil
6141590 quality in dryland area| doi: 10.1016/j.still.2021.105069
Banerjee, Hirak; Garai, Sourav; Kundu, Rajib; Mondal, Mousumi; Sarkar, Sukamal | Mulching and nitrogen management in peanut cultivation: an evaluation of productivity, energy
6141594 trade-off, carbon footprint and profitability| doi: 10.1007/s40974-020-00189-9
Avasthe, R. K.; Babu, Subhash; Chandra, Puran; Das, Anup; Kumar, Amit; Mohapatra, K. P.; Singh, Raghavendra; Singh, Vinod K.; Yadav, Gulab Singh | Crop productivity, soil
6141596 health, and energy dynamics of Indian Himalayan intensified organic maize-based systems| doi: 10.1016/j.iswcr.2020.11.003
Bohra, J. S.; Kumar, Maneesh; Singh, S. K. | Cumulative Effect of Organic and Inorganic Sources of Nutrients on Yield, Nutrients Uptake and Economics by Rice-Wheat Cropping
6141608 System in Indo-Gangetic Plains of India| doi: 10.1080/00103624.2020.1729788
Nigam, G. K.; Sahu, R. K.; Sahu, Radhika; Sinha, Jitendra | Used plastic materials as mulches: An alternative to conventional black plastic mulch for small and marginal farmers|
6141612 doi: 10.1016/j.pce.2019.02.005
Bhatnagar, Amit; Chandra, Subhash; Chaturvedi, Sumit; Datta, Debarati; Ghosh, Sourav; Kar, Gouranga; Nath, Chaitanya Prasad; Singh, Gurvinder; Singh, Veer | Soil-plant water
dynamics, yield, quality, and profitability of spring sweet corn under variable irrigation scheduling, crop establishment and moisture conservation practices| doi:
6141614 10.1016/j.fcr.2022.108450
Meena, Raj Pal; Tripathi, S. C.; Venkatesh, Karnam | Environmentally sound alternative cropping systems for rice-wheat systems in North West India| doi: 10.1007/s00704-022-
6141624 03948-2
Chandrashekara, Keerthi Manikyanahalli; Jagan Mohan Reddy, Mogili; Jahan, Afifa; Kumar, Parimal; Prabhakar Reddy, Thalla; Rajashekar, Banda; Rajashekhar, Mandla;
Ramakrishna, Kommagoni; Satyanarayana, Eetela; Shankar, Adhi; Shravika, Lakkakula | Evaluation of integrated pest management module for pink bollworm, Pectinophora
6141632 gossypiella (Saunders) and its economic analysis under farmer's field conditions| doi: 10.1080/09670874.2022.2096269
Bhatnagar, Amit; Chandra, Subhash; Chaturvedi, Sumit; Pyne, Suhita; Raverkar, K. P.; Roy, Arkaprava; Singh, Gurvinder | Economic, water saving and energy efficient crop
6141634 establishment and inter-culture practices for wheat (Triticum aestivum L.) in Indian humid subtropics| doi: 10.1080/03650340.2022.2157407
Bhat, Mohammad Anwar; Brestic, Marian; EL Sabagh, Ayman; Ganai, Manzoor A.; Hussain, Ashaq; Jehangir, Intikhab Aalum; Mahdi, Syed Sheraz; R. Sofi, Najeeb; Raja, Waseem;
Skalicky, Milan; Soufan, Walid; Teeli, Nazir Ahmad; Ueda, Akihiro; Wani, Shabir H. | Response of Rice (Oryza sativa L.) Cultivars to Variable Rate of Nitrogen under Wet Direct
6141646 Seeding in Temperate Ecology| doi: 10.3390/su14020638
Alam, Badre; Banjara, Tej Ram; Kumar, Sushil; Taria, Sukumar; Verma, S. K.; Yadav, Ashok | Tillage based Crop Establishment Methods and Zinc Application Enhances
Productivity, Grain Quality, Profitability and Energetics of Direct-Seeded Rice in Potentially Zinc-Deficient Soil in the Subtropical Conditions of India| doi:
6141648 10.1080/00103624.2022.2043340
Bhatt, Bhagwati Prasad; Choudhary, Jaipal Singh; Hans, Hansraj; Hazra, Kali Krishna; Kumar, Rakesh; Mishra, Janki Sharan; Mondal, Surajit; Rao, Karnena Koteswara | Crop
6141650 rotation and tillage management options for sustainable intensification of rice-fallow agro-ecosystem in eastern India| doi: 10.1038/s41598-020-67973-9
Choudhury, B. U.; Das, Shaon Kumar; Ghosh, Goutam Kr; Hazarika, S.; Mishra, V. K. | Developing biochar and organic nutrient packages/technology as soil policy for enhancing
6141662 yield and nutrient uptake in maize-black gram cropping system to maintain soil health| doi: 10.1007/s13399-022-02300-y
Bochalya, R. S.; Gupta, A. K.; Kumar, Deepak; Kumar, P.; Mehta, Swati; Puniya, R.; Thakur, N. P. | Residual Effect of Fertility Levels, Biofertilizer and Foliar Nutrition on Yield and
6141662 Yield Attributes of Summer Blackgram (Vigna mungo L.) in Wheat-blackgram Cropping System under Subtropical Conditions in Jammu| doi: 10.18805/LR-4843
Kumar, Abhay; Kumar, Avinash; Kumar, Rakesh; Kumar, Ujjwal; Mondal, Surajit; Monobrullah, Md; Raman, Rohan Kumar; Singh, Dhiraj Kumar; Singh, Rajeev; Sundaram, Prem
6141663 Kumar; Upadhyaya, Ashutosh | Efficiency of different cropping systems for sustaining productivity in middle Indo-Gangetic Plains| doi: 10.56093/ijas.v92i8.117619
Ali, Baber; Hafeez, Aqsa; Kumar, Suresh; Manuja, Sandeep; Poczai, Peter; Saini, Ankit | Impact of Cultivation Practices and Varieties on Productivity, Profitability, and Nutrient
6141667 Uptake of Rice (Oryza sativa L.) and Wheat (Triticum aestivum L.) Cropping System in India| doi: 10.3390/agriculture12101678
Bozhbanov, Alikhan; Orynbasarova, Gulnar; Suleimenova, Mariya; Suleimenova, Naziya; Yerekeyeva, Svetlana | Environmental Monitoring of the Sustainability and Productivity of
6141682 the Agroecosystem of Oilseeds in South-East Kazakhstan| doi: 10.12911/22998993/139114
Aisakulova, Khaiyrnisa; Bissembayev, Anuarbek; Saljnikov, Elmira; Turebayeva, Sagadat; Yerkin, Akbota; Yesseyeva, Gainiya; Zhapparova, Aigul | Productivity of Rainfed Winter
6141687 Wheat with Direct Sowing and Economic Efficiency of Diversified Fertilization in Arid Region of South Kazakhstan| doi: 10.3390/agronomy12010111
6141688 Bar-Tal, A.; Danga, B. O.; Ouma, J. P.; Wakindiki, I. I. C. | Chickpea-Wheat Rotation for Higher Production in a Humid Tropical Region| doi: 10.2134/agronj2009.0145
Bruce, Toby J.; Khan, Zeyaur R.; Midega, Charles A. O.; Pickett, John A.; Pittchar, Jimmy; Salifu, Daisy | Cumulative effects and economic benefits of intercropping maize with
6141692 food legumes on Striga hermonthica infestation| doi: 10.1016/j.fcr.2013.09.012
Mukasa, D.; Uringi, N. O.; Wairegi, L. W. I.; van Asten, P. J. A. | Agronomic and economic benefits of coffee-banana intercropping in Uganda's smallholder farming systems| doi:
6141697 10.1016/j.agsy.2010.12.004

6141703 Choudhary, Madhu; Datta, Ashim; Jat, Hanuman S.; Jat, M. L.; Meena, R. P.; Mondal, Sandip; Sapkota, Tek B.; Sharma, Parbodh C.; Yadav, Arvind K. | Sustainable intensification influences soil quality, biota, and productivity in cereal-based agroecosystems| doi: 10.1016/j.apsoil.2018.02.027

6141719 Baaru, Mary; Kimaru-Muchai, W. Serah; Muna, W. Monica Mucheru-; Ngetich, K. Felix | Zai pits for heightened sorghum production in drier parts of Upper Eastern Kenya| doi: 10.1016/j.heliyon.2021.e08005

6141721 Job, Kihara; Michael, Kinyua; Monicah, Mucheru-Muna; Peter, Bolo | Optimizing interaction between crop residues and inorganic N under zero tillage systems in sub-humid region of Kenya| doi: 10.1016/j.heliyon.2021.e07908

6141730 Diiro, Gracious; Ekesi, Sunday; Kassie, Menale; Midingoyi, Soul-kifouly G.; Muriithi, Beatrice | Do Farmers and the Environment Benefit from Adopting Integrated Pest Management Practices? Evidence from Kenya| doi: 10.1111/1477-9552.12306

6141731 Kemboi, Evans; Kiprotich, Collins; Muendo, Kavoi | Crop diversification analysis amongst smallholder farmers in Kenya(empirical evidence from Kamariny ward, Elgeyo Marakwet County)| doi: 10.1080/23311932.2020.1834669

6141732 Mucheru-Muna, M. W.; Ndeleko-Barasa, E. M.; Ngetich, K. F. | Agronomic and financial benefits of direct Minjingu phosphate rock use in acidic humic nitisols of Upper Eastern Kenya| doi: 10.1016/j.heliyon.2021.e08332

6141735 Flavel, Richard; Guppy, Chris; Im, Sophoeun; Martin, Robert; Montgomery, Stephanie; Phan, Sophanara; Tighe, Matthew; Wright, Graeme | Productivity and profitability of upland crop rotations in Northwest Cambodia| doi: 10.1016/j.fcr.2016.12.010

6141743 An, Chanratha; Malacrino, Antonino; Miller, Sally; Norton, George; O'Rourke, Megan E.; Porras, Mitzy F.; Rajotte, Edwin G.; Rosa, Cristina; Seng, Kim Hian; Socheath, Ong | An Integrated Pest Management Program Outperforms Conventional Practices for Tomato (Solanum lycopersicum) in Cambodia| doi: 10.1094/PHP-09-21-0123-RS

6141745 El-Shater, Tamer; Yigezu, Yigezu A. | Can Retention of Crop Residues on the Field Be Justified on Socioeconomic Grounds? A Case Study from the Mixed Crop-Livestock Production Systems of the Moroccan Drylands| doi: 10.3390/agronomy11081465

6141749 El-Shater, Tamer; Yigezu, Yigezu A. | Can Retention of Crop Residues on the Field Be Justified on Socioeconomic Grounds? A Case Study from the Mixed Crop-Livestock Production Systems of the Moroccan Drylands| doi:

6141753 Abera, Tolera; Kumbi, Haji; Midega, Tesfaye; Tola, Buzuayehu; Tufa, Tolcha | Effect of Integrated Inorganic and Organic Fertilizers on Yield and Yield Components of Barley in Liben Jawi District| doi: 10.1155/2018/2973286

6141771 Fonteyne, Simon; Martinez Gamino, Miguel-Angel; Saldivia Tejeda, Abel; Verhulst, Nele | Conservation Agriculture Improves Long-term Yield and Soil Quality in Irrigated Maize-oats Rotation| doi: 10.3390/agronomy9120845

6141772 Farnworth, Cathy Rozel; Mupangwa, Walter; Mutenje, Munyaradzi Junia; Nyagumbo, Isaiah; Stirling, Clare; Thierfelder, Christian | A cost-benefit analysis of climate-smart agriculture options in Southern Africa: Balancing gender and technology| doi: 10.1016/j.ecolecon.2019.05.013

6141776 Chikowo, Regis; Chimonyo, Vimbayi; Gwenambira, Chiwimbo; John, Innocensia; Nord, Alison; Snapp, Sieglinde | Marginal more than mesic sites benefit from groundnut diversification of maize: Increased yield, protein, stability, and profits| doi: 10.1016/j.agee.2021.107585

6141779 Bado, Boubie Vincent; Manzo, Maman Laminou Sanoussi; Whitbread, Anthony | Improving agricultural productivity using agroforestry systems: Performance of millet, cowpea, and ziziphus-based cropping systems in West Africa Sahel| doi: 10.1016/j.agee.2020.107175

6141793 Diels, J.; Franke, A. C.; Oyewole, B. D.; Schulz, S.; Tobe, O. K. | THE ROLE OF CATTLE MANURE IN ENHANCING ON-FARM PRODUCTIVITY, MACRO- AND MICRO-NUTRIENT UPTAKE, AND PROFITABILITY OF MAIZE IN THE GUINEA SAVANNA| doi: 10.1017/S0014479708006443

6141801 Avav, Ter-Rumun; Chikoye, David; Ellis-Jones, Jim; Ibana, Simon E.; Kormawa, Patrick; Udensi, Udensi E. | Options for cogongrass (Imperata cylindrica) control in white Guinea yam (Dioscorea rotundata) and cassava (Manihot esculenta)| doi: 10.1614/WT-04-310R2.1

6141813 Adigbo, S. O.; Adigbo, V. B.; Okeleye, K. A. | Performance of upland rice fitted into lowland rice-vegetable/cowpea sequence in rainfed inland valley| doi: 10.2134/agronj2005.0170

6141832 Ehanire, Bryan; Otoadese, Joshua; Oyeogbe, Anthony | Diversification of maize-based intercropping systems in tropical rainforest agroecosystem of Nigeria: productivity, profitability, and soil fertility| doi: 10.17170/kobra-202011192213

6141833 Gathala, Mahesh Kumar; Jha, Raj Kant; Panday, Dinesh; Pokharel, Dipendra; Shrestha, Hari Krishna; Tiwari, Thakur Prasad | Is conservation agriculture a potential option for cereal-based sustainable farming system in the Eastern Indo-Gangetic Plains of Nepal?| doi: 10.1080/23311932.2018.1557582

6141839 Ali, Syed N. Azam; Iqbal, Munawar; Maqsood, Muhammad; Shehzad, Muhammad Asif | Rice cultures and nitrogen rate effects on yield and quality of rice (Oryza sativa L.)| doi: 10.3906/tar-1203-5

6141846 Ahmad, Naeem; Ehsan-Ul-Haq; Javid, Shahid; Mahmood, Abid; Majeed, Abdul; Mehdi, Shahzada Munawar; Mehmood, Atif; Niaz, Abid | Influence of P-enriched compost application on economics and P use efficiency of a maize-wheat rotation system| doi: 10.1016/j.cj.2018.05.007

6141856 Ali, Shahzad; Daur, Ihsanullah; Inamullah; Jan, Amanullah; Khan, Ahmad; Khan, Muhammad Ijaz; Manzoor; Sohail, Amir; Zhang, Jiahua | Soil amendments strategies to improve water-use efficiency and productivity of maize under different irrigation conditions| doi: 10.1016/j.agwat.2018.08.009

6141861 Asad, Saeed A.; Farooq, Muhammad; Nadeem, Asif; Nawaz, Ahmad; Rehman, Abdul; Ullah, Aman | Manganese nutrition improves the productivity and grain biofortification of fine grain aromatic rice in conventional and conservation production systems| doi: 10.1007/s10333-016-0573-8

Farooq, Muhammad; Farooq, Shahid; Hussain, Mubshar; Jabran, Khawar; Nawaz, Ahmad; Shahzad, Muhammad | Economic assessment of conventional and conservation tillage
6141864 practices in different wheat-based cropping systems of Punjab, Pakistan| doi: 10.1007/s11356-017-0136-6
Hussain, Mubshar; Ijaz, Muhammad; Mahmood, Khalid; Sattar, Abdul; Shahid, Muhammad; Sher, Ahmad; Tahir, Muhammad; Ul-Allah, Sami | Combined application of biochar and
6141866 PGPR consortia for sustainable production of wheat under semiarid conditions with a reduced dose of synthetic fertilizer| doi: 10.1007/s42770-019-00043-z
Farooq, Muhammad; Iqbal, Muhammad; Javed, Atif; Lal, Rattan; Shehzadi, Ruqia | Plastic Film and Straw Mulch Effects on Maize Yield and Water Use Efficiency under Different
6141868 Irrigation Levels in Punjab, Pakistan| doi: 10.17957/IJAB/15.0955
Abid, Muhammad; Shahzad, Khurram; Sintim, Henry Y. | Wheat Productivity and Economic Implications of Biochar and Inorganic Nitrogen Application| doi:
6141876 10.2134/agronj2018.01.0055
Aziz, Marjan; Javid, Shahid; Khan, Azra; Muhammad, Ghulam; Naseem, Waqas; Rafique, Rizwan; Rizvi, Sultan A.; Sajjad, Muhammad R.; Subhani, Abid | Characterization of
6141896 cowpea to harvest rainwater for wheat in semiarid conditions| doi: 10.5424/sjar/2021193-16645
Hussain, Hadi; Jamil, Ihsan; Jun, Wen; Mughal, Bushra; Waheed, Junaid; Waseem, Muhammad | Agricultural Innovation: A comparative analysis of economic benefits gained by
6141903 farmers under climate resilient and conventional agricultural practices| doi: 10.1016/j.landusepol.2021.105581
Amanullah; Azam, Muhammad; Farooq, Omer; Jamal, Aftab; Khan, Imad; Mihoub, Adil; Radicetti, Emanuele; Roberto, Mancinelli; Saeed, Muhammad Farhan; Zia, Adil | Partial
Substitution of Chemical Fertilizers with Organic Supplements Increased Wheat Productivity and Profitability under Limited and Assured Irrigation Regimes| doi:
6141913 10.3390/agriculture12111754
6141916 Bizoza, A. R.; De Graaff, J. | FINANCIAL COST- BENEFIT ANALYSIS OF BENCH TERRACES IN RWANDA| doi: 10.1002/ldr.1051
Dejana, Dzigurski; Ljiljana, Nikolic; Maja, Manojlovic; Martina, Bavec; Ranko, Cabilovski; Srdan, Seremesic | Ground cover management and farmyard manure effects on soil
6141928 nitrogen dynamics, productivity and economics of organically grown lettuce (Lactuca sativa L. subsp secalina)| doi: 10.1016/S2095-3119(16)61565-4
Aw-Hassan, A.; El-Shater, Tamer; Haddad, Atef; Khalil, Yaseen; Loss, Stephen; Mugera, Amin; Piggin, Colin; Yigezu, Yigezu A. | Does Zero Tillage Improve the Livelihoods of
6141943 Smallholder Cropping Farmers?| doi: 10.1111/1477-9552.12133
Bibi, Irshad; Hilger, Thomas; Hussain, Khalid; Ilyas, Ayesha | Sustainable Soil Loss Management in Tropical Uplands: Impact on Maize-Chili Cropping Systems| doi:
6141947 10.3390/su13116477
Bekunda, Mateete; Fischer, Gundula; Kihara, Job; Kimaro, Anthony; Kinyua, Michael; Kizito, Fred; Manda, Julius; Mutungi, Christopher; Okori, Patrick; Swai, Elirehema |
6146770 Contributions of integrated soil fertility management (ISFM) to various sustainable intensification impact domains in Tanzania| doi: 10.1016/j.agsy.2022.103496
Kaizzi, CK; Ssali, H; Vlek, PLG | Differential use and benefits of Velvet bean (Mucuna pruriens var. utilis) and N fertilizers in maize production in contrasting agro-ecological
6146779 zones of E. Uganda| doi: 10.1016/j.agsy.2005.06.003
Fatumah, Nakiguli; Mohammed, Ssemwanga; Tilahun, Seifu A. | Water use efficiency, grain yield, and economic benefits of common beans (Phaseolus vulgaris L.) under four soil
6146782 tillage systems in Mukono District, Uganda| doi: 10.1016/j.heliyon.2021.e06308
Ala-Kokko, Kristiina; Mulimbi, Willy; Nalley, Lawton Lanier; Strauss, Johann | Economic and environmental comparison of conventional and conservation agriculture in South
6146787 African wheat production| doi: 10.1080/03031853.2023.2169481
Cheesman, Stephanie; Rusinamhodzi, Leonard; Thierfelder, Christian | Benefits and challenges of crop rotations in maize-based conservation agriculture (CA) cropping systems
6146819 of southern Africa| doi: 10.1080/14735903.2012.703894
Chikowo, R.; Giller, K. E.; Mapfumo, P.; Mtambanengwe, F.; Rufino, M. C.; Rurinda, J.; van Wijk, M. T. | Comparative assessment of maize, finger millet and sorghum for household
6146841 food security in the face of increasing climatic risk| doi: 10.1016/j.eja.2013.12.009
Mupangwa, W.; Mutsamba, E. F.; Nyagumbo, I | Forage and maize yields in mixed crop-livestock farming systems Enhancing forage and maize yields in mixed crop-livestock
6146887 systems under conservation agriculture in sub-humid Zimbabwe| doi: 10.1016/j.njas.2019.100317
Groot, Jeroen C. J.; Mapfumo, Paul; Mbanyele, Vengai; Mtambanengwe, Florence; Nezomba, Hatirarami | Combinations of in-field moisture conservation and soil fertility
6146888 management reduce effect of intra-seasonal dry spells on maize under semi-arid conditions| doi: 10.1016/j.fcr.2021.108218

Table S4 | Field descriptions of meta-dataset. The meta-dataset can be found here.

Field name	Description
_obs	value for observed period (mid point of year_start and year_end)
_2015	value for the target year of 2015
xrat_	USD exchange rate (PA.NUS.FCRF)
cpi_	consumer price index (FP.CPI.TOTL)
ppp_	local currency units per international $ (PA.NUS.PPP)
MeanT	experimental treatment value (as reported)
MeanC	control treatment value (as reported)
Units	unit of MeanT and MeanC (as reported)
_local	values converted to local currency units (where reported in local currency units values are unchanged)
local_2015	values adjusted to 2015 using CPI in local currency
2015_usd	values adjusted to 2015 using CPI, local currency converted to USD using xrat_2015
2015_ppp_intusd	values adjusted to 2015 using CPI in local currency, local currency converted to international $ using ppp_2015

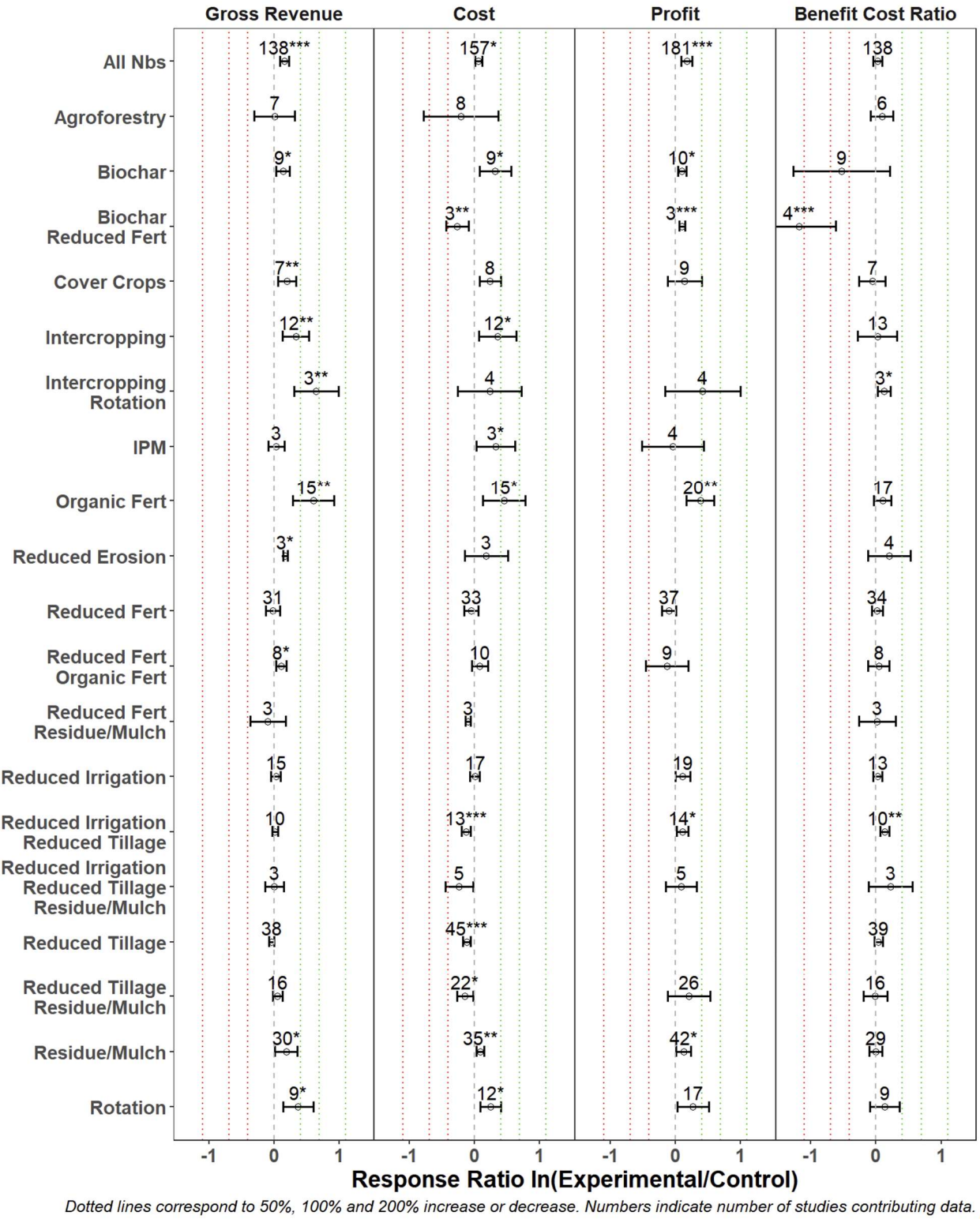


Figure S1 | The economics of agricultural NbS applied alone or in specific bundles. Benefit cost ratio are gross revenue divided by costs. All units are log-RRs with vertical bars marking percent differences for the NbS relative to its relevant control. Values are reported in Table 3.

i