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Research paper

Motivations for the use of sustainable intensification practices among smallholder farmers in Tanzania and Malawi

Isaac Jonathan Jambo[a,b], Jeroen C.J. Groot[a,*], Katrien Descheemaeker[c], Mateete Bekunda[b], Pablo Tittonell[a]

[a] Farming Systems Ecology, Wageningen University & Research, P.O. Box 430, 6700 AK, Wageningen, the Netherlands
[b] International Institute for Tropical Agriculture (IITA), C/O AVRDC, The World Vegetable Centre, P.O. Box 10, Duluti, Arusha, Tanzania
[c] Plant Production Systems, Wageningen University & Research, P.O. Box 430, 6700 AK Wageningen, The Netherlands

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ABSTRACT

Agricultural techniques and technologies that could foster sustainable intensification of farming (hereafter: SI practices) can originate from existing farm practices, from the adoption of externally suggested new practices, or from an adaptation of existing or new practices. The rate at which farmers use SI practices is often low and influenced by on-farm biophysical and socio-economic conditions. There is a narrow understanding of the role of motivations and the balance between external incentives and intrinsic motivations for use of SI practices. We analysed the role of intrinsic and extrinsic motivations among 246 sampled households alongside the perceived benefits and constraints from SI practices in five districts of Malawi and Tanzania. Our results showed that farmer decisions were not exclusively dependent on external incentives, but also on intrinsic values which farmers attach to their production resources and farming practices. Despite various benefits perceived, farmers highlighted the lack of financial resources as a major constraint to the use of externally proposed SI practices. While we hypothesized that intrinsic motivation would be much stronger than extrinsic in influencing decisions to use SI practices, our results demonstrated equal importance of intrinsic and extrinsic motivations in influencing the number of SI practices which smallholder farmers used. We suggest explicitly addressing both intrinsic and extrinsic motivations in further research in combination with socio-economic and biophysical variables to give a better reflection of what drives farmers' decisions to use more sustainable farming practices. We argue that the design of SI research programs should support motivations of diversified farmers to participate in such programs. Emphasising farmers' autonomy, a key to intrinsic motivation, can stimulate ownership of SI projects and smoothen the process of adoption, adaptation and use of SI practices by farmers, and is expected to reduce the mismatch between proposed practices and farmers' expectations.

1. Introduction

Increasing agricultural productivity while reducing negative effects on the environment is required to meet global demand for food, feed, fibre and fuel with limited expansion of agricultural land (Bajželj et al., 2014; Hubert et al., 2010; Popp et al., 2014). Intensification of smallholder agriculture can contribute considerably to satisfying this demand since smallholder farmers produce a large proportion of food globally (Vanlauwe et al., 2012). Therefore, research for development (R4D) projects focusing on smallholder farms in the tropics propose agricultural practices (including technologies and management techniques) to increase agricultural productivity, while simultaneously improve environmental quality and social equity, i.e. sustainable intensification (SI). Promoted practices under SI can originate from existing farm practices, from adoption of externally suggested new practices, or from adaptation of existing or new practices. Irrespective of their origin, use of SI practices by farmers is often limited. Decisions to use SI practices may be influenced by many factors such as on-farm biophysical conditions and resource availability, external drivers like availability of inputs, technologies, knowledge and supporting policies, perceived market stability and climatic risks, and the characteristics and motivations of individual farmers. However, there is limited understanding of the role of motivations and the balance between external incentives (for instance subsidies or taxes, or social pressure) and more intrinsic motivations related to farmers' goals and values.

Agricultural research and extension studies have identified and

* Corresponding author.
E-mail address: jeroen.groot@wur.nl (J.C.J. Groot).

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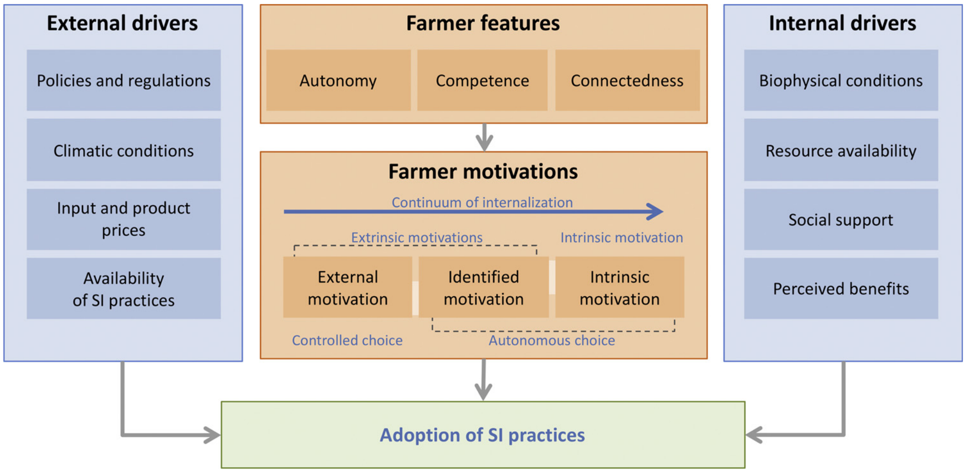

Fig. 1. Categories of motivations to regulate behaviour on a continuum of internalization according to Self-Determination Theory of Ryan and Deci (2000). Extrinsic motivations have separable outcomes, while intrinsic motivations are conducted out of personal interest. Identified and intrinsic motivations both involve an autonomous choice while external motivations relate to controlled behaviour. Based on Garini et al. (2017).

categorized numerous variables that help to explain smallholder farmers' decisions to adopt and adapt practices and innovate on their farms. Meijer et al. (2015) summarized such kind of studies for Sub Saharan Africa (SSA) that linked smallholder farmers' decisions to use new practices to social and economic variables such as age, gender, income levels, wealth status, position in the society, past experience, exposure to project implementation and land tenure security of the household head or spouse. However, due to limitations in the ability of economic factors alone to explain such decisions (Artikov et al., 2006; Sautter et al., 2011), social scientists have emphasized the importance of non-economic factors that explain human behaviour, such as the motivation to embrace and practice agricultural innovations (Peterson et al., 2012). Understanding of human motivation patterns could enhance the effective implementation of agricultural projects (Adams, 2005). If farmers are experienced and autonomously implementing practices in an environment where they feel connected to other farmers and the society, dissemination and diffusion of practices become facile. Allowing farmers to autonomously choose among the available set of SI practices can enhance their interest, by avoiding a mismatch between farmers' context and needs and the available farm management practices.

Here we identify and analyse motivations of farmers to use SI practices. The focus is on practices that were either proposed by an R4D project or those originating from farmer-led innovation initiatives (Hoeschle-Zeledon, 2015). The study further analyses attitudes, benefits and barriers of SI and it is guided by the following research questions;

i What are the socio-economic characteristics and agricultural performance of smallholder farms in the study sites?
ii What attitudes and perceived benefits and barriers are associated with the use of SI practices across the sampled farms?
iii Are farmers across the study sites and agroecozones intrinsically and/or extrinsically motivated to sustainably intensify their agricultural systems?
iv Do intrinsic and/or extrinsic motivations of smallholder farmers influence the number of practices used by smallholder farmers?

By definition, an attitude is a way in which individuals positively or negatively engage in a certain type of behaviour (Shaman Herath, 2010). Attitudes comprise a set of conducts, beliefs and emotions concerning a particular subject and are usually a product of upbringing or experience (Chaiklin, 2011). Understanding the attitude of farmers in relation to perceived benefits and barriers around agricultural practices is important because farmers are most likely to adopt and adapt practices that they perceive to be favourable (Obayelu et al., 2017). Motivation is mainly concerned with how individuals are moved to act (Adams, 2005).

2. Theoretical background

Our study is built upon self-determination theory (SDT). SDT addresses human behaviour with a focus on motivation and personality (Deci and Ryan, 2011). It recognises three basic psychological needs of individuals for autonomy, competence, and connectedness, which form the basis on which motivation is built. Autonomous behaviour "is willingly enacted by an individual when s/he fully endorses the actions in which s/he is engaged and/or the values expressed by the actions. People are therefore most autonomous when they act in accord with their authentic interests or integrated values and desires" (Chirkov et al., 2003). Competence reflects the importance of being skilled and knowledgeable about activities that are conducted and being able to maintain those personal skills and knowledge through action. Connectedness indicates the need of people to be connected with others in the society, and to have the awareness that others love, care, accept and support their actions and behaviour.

According to SDT, motivation to perform a particular behaviour can range from extrinsically regulated, based on external incentive or coercion, to intrinsic motivation (volition) (Wilson et al., 2008; Garini et al., 2017). Two forms of extrinsic motivation are distinguished: external motivation is controlled by external incentives and associated with an externally imposed rule, reward (e.g., a subsidy) or punishment (e.g., a tax), while identified motivation is autonomously controlled but involves a separable reward, like good health or a fertile soil. Intrinsic motivation is based on autonomous choice to deliberately choose certain behaviour to pursue a personal intrinsic interest, goal or value. Fig. 1 shows this gradient of motivation. In the context of adoption of innovations, more internalized behaviour is expected to lead to a higher probability of adoption, a stronger persistence of implemented innovations and better quality of innovations being implemented (Lam et al., 2010).

Successful implementation of agricultural R4D projects is strongly dependent on changes in farmer behaviour and their efforts to change the agro-ecosystems that they manage. In this paper, we investigate the role of external and intrinsic motivations in adoption of SI practices by smallholder farmers in Tanzania and Malawi. We hypothesize that farmers are intrinsically motivated to improve farm productivity and sustainability, and that the role of extrinsic motivation in shaping the adoption of SI practices is limited.

3. Materials and methods

3.1. Project and case study sites

Africa Research In Sustainable Intensification for the Next Generation (Africa RISING) is a R4D project operating in Malawi and

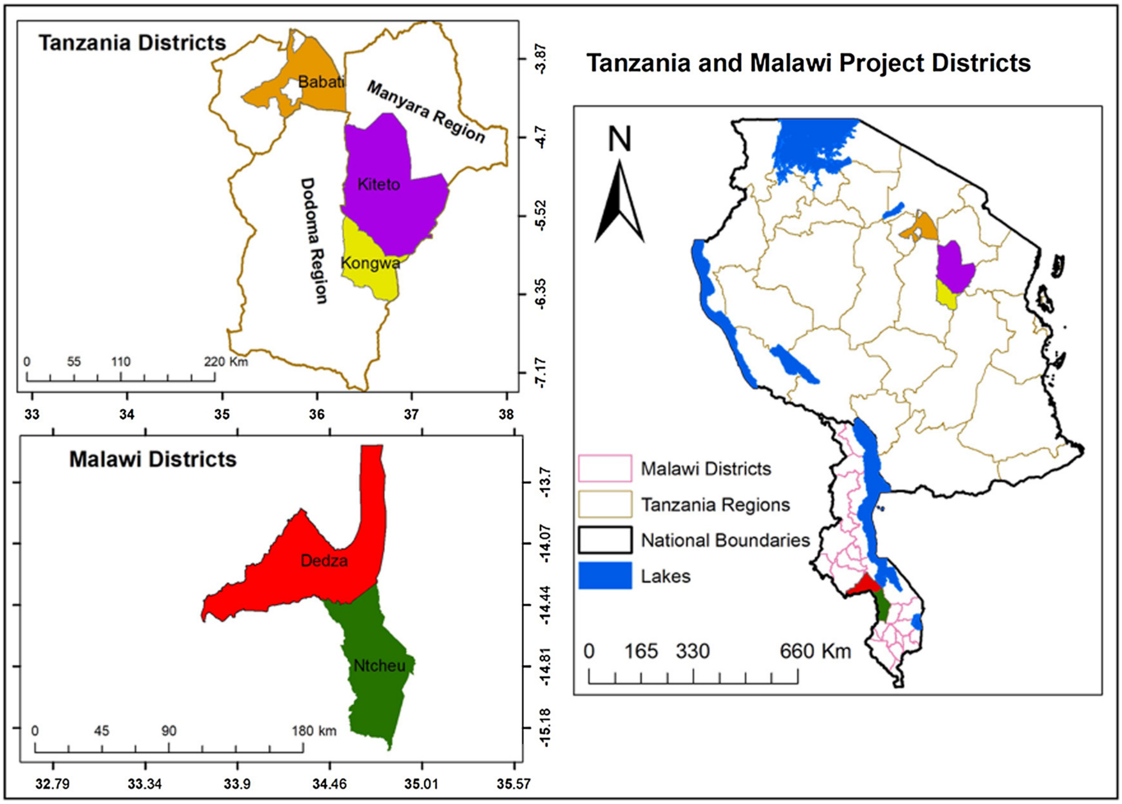

Fig. 2. The study areas for Babati, Kongwa and Kiteto in Tanzania and Dedza and Ntcheu in central Malawi located within the Africa RISING project sites.

Table 1
Baseline social and economic conditions for Malawi (Dedza and Ntcheu districts) and Tanzania (Babati, Kongwa and Kiteto districts).
Source: Data for Tanzania was summarised from (Hillbur, 2013), Malawi data was collected from online sources (Trading-Economics, 2018).

Socio-economic conditions	**Malawi**		**Tanzania**		
GDP	6.5 billion US$		52.09 billion US$		
GDP per capita	486.45 US$		900.52 US$		
Agricultural GDP	28.6%		23.4%		
Livestock GDP	7.0%		7.4%		
Major rural economic activities	Rain fed agriculture, irrigation, off-farm labour		Rain fed agriculture, livestock keeping, off-farm businesses		
Arable land per capita	0.22 ha		0.25 ha		
Median age	17.0 years		17.7 years		
District	**Dedza**	**Ntcheu**	**Babati**	**Kiteto**	**Kongwa**
Population (people)	627,704	470,778	405,500	244,669	309,973
Population density (people km^{-2})	173	137	82	15	77
Literacy levels	49%	65%	75%	61%	62%
Total land area (km^2)	3624	3424	4969	6645	4041
Average farm size (ha)	2.79	2.27	1.68	3.63	3.9

Tanzania. The aim is to sustainably intensify smallholder agricultural systems through a wide range of technologies and techniques (Table S1), including genetic improvement, natural resource management technologies, livestock-driven technologies, post-harvest and nutrition technologies (Hoeschle-Zeledon, 2015). The project is implemented through participatory action research with farmers, on-farm research trials and mother and baby demonstrations where the transfer of innovations takes place. The project established platforms for research, development and capacity building activities to facilitate co-creation and co-learning between farmers and researchers (Hoeschle-Zeledon, 2015). The research sites are located in Manyara (Babati and Kiteto districts) and Dodoma (Kongwa district) regions of Tanzania and Central region (Dedza and Ntcheu districts) of Malawi (Fig. 2; Table 1).

In our analysis, the study area in Babati was divided into two zones with contrasting agro-ecological conditions: an upper zone at higher altitudes (1500–2000 m above sea level (m.a.s.l.; H) and a lower (1000–1500 m.a.s.l.; L) zone. The case study sites were chosen to represent a range of agro-ecological conditions and they exhibit a strong potential for agricultural growth. The population densities are relatively high with large proportions of people who rely on small-scale agriculture.

3.2. Data collection

The study used both primary and secondary data. Primary data was collected from farmers in years 2015 and 2016 in all the Africa RISING sites of Tanzania and Malawi. The sampling of households for primary data collection was purposive based on a previous survey (Timler et al., 2014a, 2014b) and the same households were contacted. The original sampling was aided by a Y Frame method to ensure a representative sampling in the selected villages (Tittonell et al., 2013). The entire sample size was 246 households of which 93 households were from Babati and 78 were from Kongwa and Kiteto districts in Tanzania while 75 households were from Dedza and Ntcheu districts in Malawi.

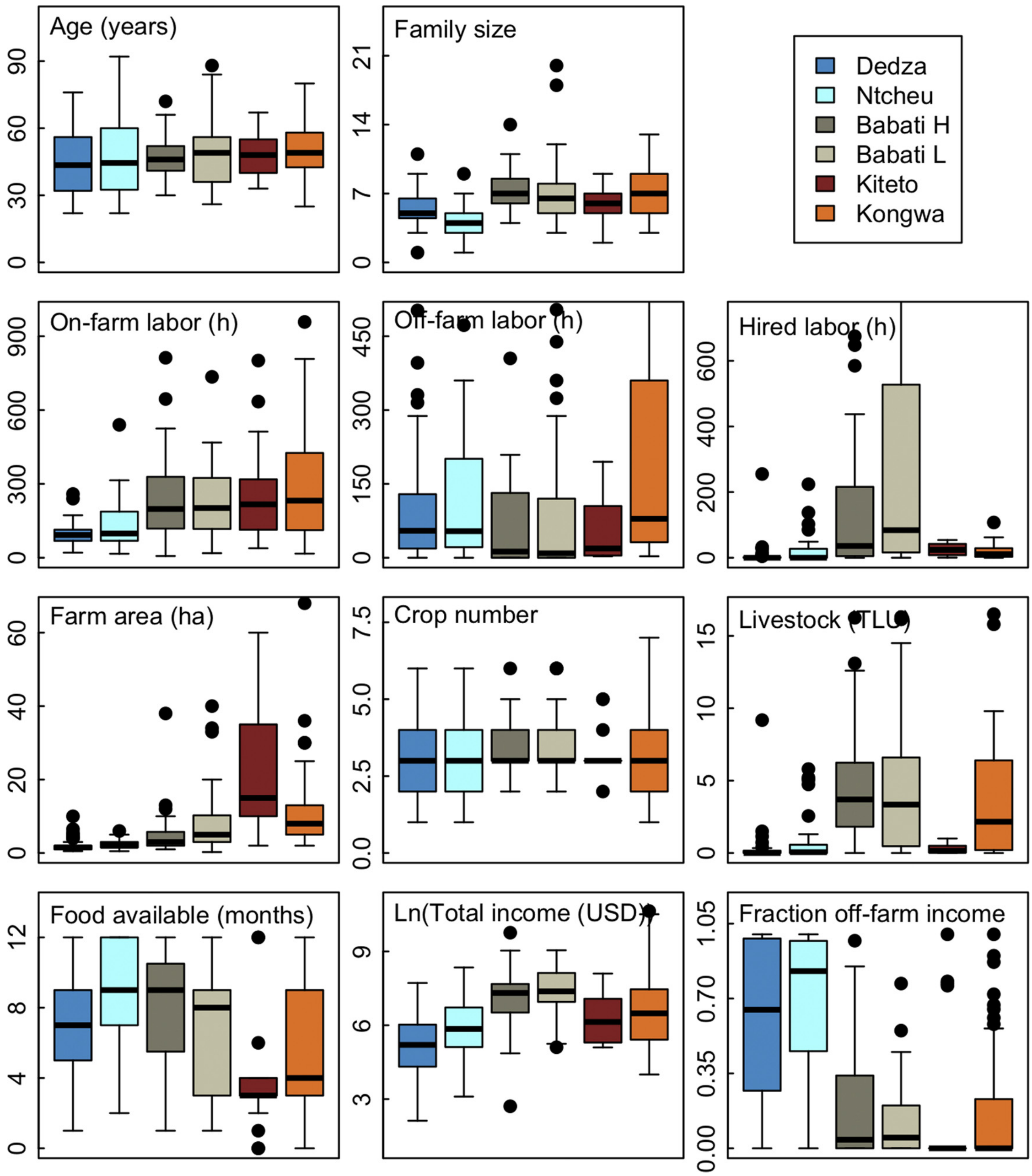

Fig. 3. Farm and household characteristics of smallholder farms in case study areas in Babati, Kongwa and Kiteto districts (Tanzania) and Dedza and Ntcheu districts (Malawi).

Farmers were interviewed upon giving consent. Most of them were directly or indirectly exposed to the Africa RISING project and had prior knowledge of sustainable farming practices. The main purpose of the follow-up surveys was to add motivation related variables to the original dataset of Timler et al. (2014a). Additional data were collected using key informant interviews, focus group discussions and semi-structured questionnaires. The key informants were 3–5 experts on farming per district, who were interviewed to gain a better understanding of the heterogeneity of the farmer population, the main farming practices and the interactions of farmers with R4D projects. One focus group discussion with farmers was organised per village before the start of the survey to obtain insights into general farmer perceptions of sustainable intensification, main constraints and opportunities for farmers, and the relationships among farmers. The resulting qualitative information assisted in putting our quantitative findings in perspective. A survey instrument for assessing motivation was developed based on a literature study on motivation which mainly focused on soil and water conservation (Napier et al., 2000; Ryan et al., 2003). The instrument focused on different aspects of motivation and sustainable intensification and contained four main sections:

- Motivation (from extrinsic to intrinsic) to use new agricultural practices.
- Farmer attitudes towards sustainable intensification and agriculture in general.
- Perceived benefits of sustainable intensification practices.
- Perceived barriers to trying out sustainable intensification practices.

Each section contained a set of predefined statements to which participants used conditioning statements to indicate the extent to which they agreed using a 5-point Likert Scale (Likert, 1932).

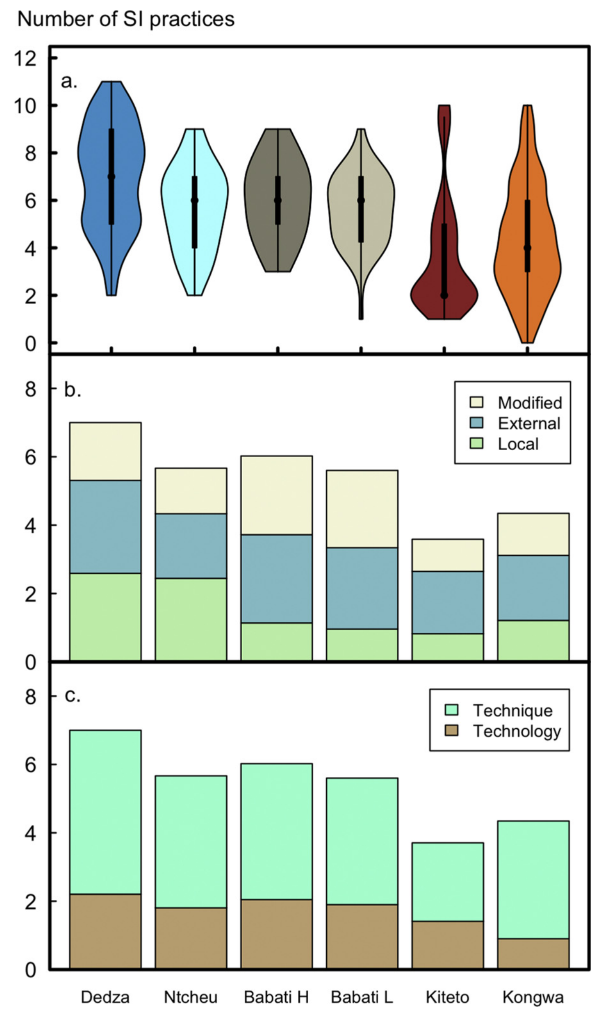

Fig. 4. Number of SI practices used by farmers in six districts in Tanzania and Malawi expressed as distribution of total number (a.), and averaged and classified by origin (b.) and type (c.).

3.3. Statistical analysis

A descriptive summary of farm household characteristics of the sampled populations was produced based on the age of the household head, labour variables (on-farm, off-farm and hired), farm area, family size, livestock numbers, crop number and months of food availability, and household income. Lorenz curves were also used to show existing inequalities in land distribution (Lorenz, 1905).

A Factor Analysis was performed to extract factors that represent correlated variables. The extracted factors with an eigenvalue larger than or equal to one were categorised into six groups, which were obtained from the survey statements, related to attitudes, perceived benefits, constraints for innovating and the external, identified and intrinsic types of motivations. Polychoric factor analysis was used because of the presence of ordinal data and because the relationship between variables is not monotonic (Flora and Curran, 2004; Holgado–Tello et al., 2010). Polychoric correlations produce the most consistent and robust estimators for ordinal data and identify latent variable structures using combinations of indicator variables. The variance contribution of each factor component was extracted using oblique axis rotations.

Further analysis was conducted on the relationship between the total number of SI practices used by farmers and variables representing location, wealth and social network (district, endowment category, participation in the project), perceptions (benefits and constraints), motivational factors (intrinsic, identified, external motivation), and various farm and household features with stepwise multiple regression procedure, using the 'MASS' R package. Forward selection of factors and variables was performed, with F-values as selection criteria for significant terms. Linear effects of main factors were tested, and their interaction with the factor 'District'. The R packages 'ggplot2′ and 'psych' were used for plotting. Redundancy analysis was used to show variations of farms across Malawi and Tanzania and the distribution of assets and labour across these farms.

4. Results

4.1. Socio-economic characteristics and performance

4.1.1. Farm and household characteristics

An overview of the main farm features of Malawi and Tanzania is presented in Fig. 3. The farms in central Malawi (Dedza and Ntcheu) had on average small family sizes (< 6 members), farm area (< 2.5 ha) and livestock numbers (< 1 TLU). Largest family sizes and herd size and medium farm areas (5–10 ha) were found in Babati and Kongwa. In contrast, in Kiteto the households were of intermediate size (6 members), while the farm area was relatively large (22 ha on average) and the herd size small with on average 0.3 TLU.

The number of cultivated crops per farm did not differ between the districts. The farmers in Malawi spent fewer labour-days on-farm than in Tanzania, and acquired most of their income from off-farm activities. In focus group discussions farmers indicated that this constituted an important strategy for diversifying income and combating risks, while providing capital for procuring farm inputs needed for SI. The total annual income was considerably lower in Dedza, Ntcheu and Kiteto (< 900 USD on average) than in Babati and Kongwa districts (> 2100 USD). The number of months with sufficient food availability from the own farm was relatively small in Kongwa (6 months) and Kiteto (4 months), as opposed to the other districts where products from the farms were sufficient to cover food requirements for 7–9 months.

The redundancy analysis (Figure S1; see Supplementary Material) further illustrates the large contrasts between farms in Malawi and Tanzania, with larger farms and more livestock in Tanzania, and relatively large number of persons per unit of farm area and more off-farm labour (hire out household labour to other farms) use in Malawi. Across all the districts in Malawi and Tanzania, there was a large variation in land sizes and land inequalities (Figure S2), with 60–80% of the total available land being shared by only 20–40% of the farms. These inequalities in land distribution were more apparent in Tanzania than in Malawi.

4.1.2. Use of SI practices

The number of implemented SI practices varied considerably in all sites of Tanzania and Malawi but was somewhat lower in Kongwa and Kiteto (Tanzania) than in other districts, while in Dedza (Malawi) the largest median and maximum numbers of implemented SI practices were recorded (Fig. 4a).

In all districts, the SI practices included locally developed, externally proposed, and modifications of existing practices (Fig. 4b). The majority of the SI practices could be considered as management techniques rather than technologies (Fig. 4c). In the focus group discussions, farmers from the various districts indicated differences in the definition of locally developed, externally proposed and modified practices. For example, maize and pigeon pea intercropping was the most popular practice in almost all the study sites of Tanzania, where it was categorised as a modified practice, yet in Malawi, it was considered an externally proposed practice. The detailed distribution of the SI practices across all the study sites based on their source and type is provided in Table S1.

Table 2
Rotated factor loadings (pattern matrix) and unique variances for attitudes on agriculture and sustainable intensification.

Variable	Factor 1	Factor 2	Uniqueness
Sustainable farming for AR and non-AR	0.7521		0.4037
All farmers must practice SLM	0.7250		0.4772
Agriculture is important in our society	0.7185		0.3993
Farmers must put up CS and perennials	0.5723		0.5135
Family farms must be maintained for legacy	0.5159		0.6391
Farming is a very satisfactory occupation	0.5089		0.7155
Extension agents should discourage SI	−0.5519		0.6554
Increasing food production efficiency is important		0.5790	0.6229
It is good to keep food prices low		0.5263	0.7198
Production methods won't sustain 10 years		0.3101	0.9015
Success must be measured in yield		−0.5854	0.5911
SI must be reinforced by price support			0.6914
Farmers value profit more than to preserve farms			0.6228
SI techniques by AR are not fully appreciated			0.9359

Factor 1: importance of agriculture to smallholder farmers. Factor 2: the need to keep food prices low, sustainability of current production methods, productivity and resource use efficiency. LR test: independent vs. saturated: $\chi^2(91) = 949.27$, $P < 0.001$. Blanks represent abs(loading) < 0.3. AR: Africa RISING, SLM: Sustainable Land Management and CS: Conservation Structures.

4.2. Perceptions of agriculture, SI benefits and barriers

4.2.1. Attitudes towards agriculture and sustainable intensification

The scorings of statements regarding the general perceptions of agriculture and sustainable intensification could be related to two factors (Figure S3a; Table 2). Most of the variable loadings on Factor 1 were related to *the level of importance that farmers attach to agriculture and SI* in general. Factor 2 contained variables related to *the need to keep food prices low, sustainability of current production methods, productivity and resource use efficiency*. The majority of farmers rated agriculture as an important and satisfactory occupation and were willing to preserve their farms through sustainable land management practices. The majority of farmers underscored the importance of keeping food prices low despite negative implications to the profitability of their farms. However, many farmers indicated a need to receive financial support to enable implementation of SI practices. The aggregate scorings comprised in Factor 1 were significantly lower ($P < 0.05$) in Kiteto (5.0 ± 0.41) than in Dedza and Ntcheu (5.5 ± 0.51 and 5.7 ± 0.33, respectively), while Babati and Kongwa had an intermediate position (5.3 ± 0.55).

4.2.2. Perceived benefits of sustainable intensification

Most of the variable loadings explaining the single retained factor regarding perceived benefits were related to improving farm productivity, quantitative aspects of agricultural production and income (Table 3 and Figure S3b). The qualitative and longer-term issues, such as mitigation of climate variability and soil and water quality, were not related to any significant factor. The aggregate scorings comprised in Factor 1 were significantly lower ($P < 0.05$) in Kiteto (5.3 ± 0.5) than in Dedza, Ntcheu and Babati (between 5.9 ± 0.6 and 6.0 ± 0.7), while Kongwa had an intermediate position (5.6 ± 0.7).

4.2.3. Perceived constraints to sustainable intensification

The factor analysis for constraints to SI resulted in one significant factor which was associated with limitations in available land, time and financial resources (Table 4; Figure S3c). Some variables such as lack of community support or knowledge were not related to any significant factor. Aggregate scorings for constraints based on factor 1 were significantly higher ($P < 0.001$) in Kongwa (4.3 ± 1.1) and Kiteto (4.4 ± 1.0) than in other districts with means ranging from (3.4 ± 1.2) in Dedza and Ntcheu to (4.0 ± 1.2) in Babati.

Table 3
Rotated factor loadings (pattern matrix) and unique variances for perceived benefits of sustainable intensification.

Variable	Factor 1	Uniqueness
Increased crop/livestock production	0.8120	0.3941
Increased agricultural income	0.7615	0.4205
Improved nutrition	0.6707	0.3807
Soil fertility improvement	0.6081	0.2617
Soil and water conservation	0.5331	0.2497
Increased fodder production	0.4273	0.6179
Increased use of manure	0.4170	0.6106
Improved water holding capacity		0.3574
Soil quality improvement		0.3806
Mitigated impacts of climate variability		0.4553
Identifying field boundaries		0.5013
Weed control in intercrops		0.7411
Natural control of pest & diseases		0.7995
Improved water quality		0.6956

Factor 1: Improving farm productivity. LR test: independent vs. saturated: $\chi^2(91) = 1708.6$, $P < 0.001$. Blanks represent abs(loading) < 0.3.

Table 4
Rotated factor loadings (pattern matrix) and unique variances for perceived constraints to SI.

Variable	Factor 1	Uniqueness
Time consuming	0.7117	0.4823
I do not have enough land	0.5858	0.5535
SI is too risky	0.4146	0.6349
Require money to implement SI	0.4107	0.8632
SI results in low yields	0.3098	0.8422
Lack of specific knowledge for SI		0.4045
I do not know how to implement		0.3978
Lack of support from community		0.5636
Not sure of the expected outcomes		0.4419
Concerned about the society		0.5639
I do not have role models on SI		0.7906
Fear of trying something new		0.7944

Factor 1: Investment costs and yield risk. LR test: independent vs. saturated: $\chi^2(66) = 815.50$, $P < 0.001$. Blanks represent abs (loading) < 0.3.

4.3. Motivation of farmers

Farmers in all the research sites expressed a strong attachment to their land, illustrating the significant role of intrinsic motivation in the implementation of SI practices (Fig. 5). Farmers are using SI innovations because of personal interest and satisfaction. Conversely, low mean scores were observed for 'maintenance of communal grazing land' in Dedza and Ntcheu (Malawi) and intermediate in Kiteto (Tanzania). Farmers in all the study regions assigned lower scores to statements related with external incentives (Fig. 6), yet many of them, especially in the sites of Tanzania, are planting pigeon peas because of the anticipated economic rewards, thereby indicating the importance of the economic performance of their own farms. Farmers in the study sites also identified themselves with different innovative practices that are promoted by SI projects (Fig. 7). Many of the SI practices were perceived to have economic as well as environmental importance such as improving productivity and food security, reducing soil erosion and mitigating effects of climate change. Levels of experienced autonomy were observed to be high in Tanzania (with score ratings above 3) but relatively low in Dedza and Ntcheu districts in Malawi (Fig. 8), where farmers were given less opportunity to choose innovative practices that they would like to implement in their farms. No significant differences were observed on the levels of competence and connectedness among the sites (Fig. 8).

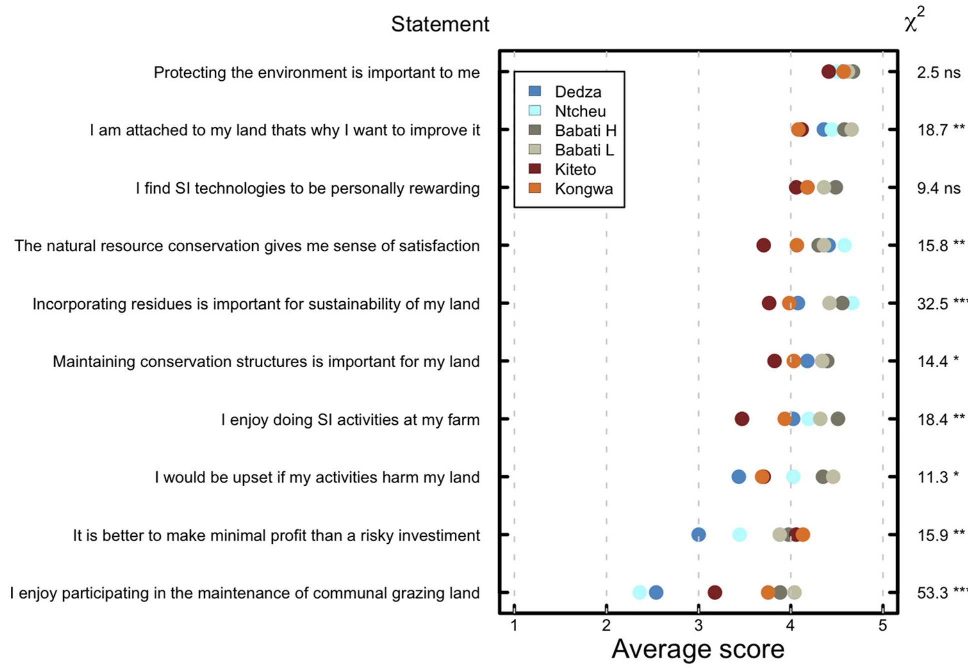

Fig. 5. Scores for statements on intrinsic motivation of farmers for implementing SI practices based on a Likert scale (1 = strongly disagree, to 5 = strongly agree). The Kruskal Wallis test compares the farmer ratings across the study districts.

4.4. Determinants of implementation of SI practices

The stepwise regression model explained 61.8% of the variation in the number of SI practices used by farmers, with the largest contributions from the differences between districts and participation in the project (Table 5). Participants in the project implemented more SI practices compared to non-participants. There was no significant relationship between the number of SI practices used and their perceived benefits, but the constraints perceived by farmers explained 8.2% of the variation in the number of SI practices being applied. Moreover, the number of SI practices was positively associated with both external and intrinsic motivational factors, while there was a negative relation with identified motivation and food expenditures (Table S6). The effect of intrinsic motivation on the use of SI practices was different between districts, as indicated by the significant interaction (Table 5). This interaction indicated that in Kongwa where the number of implemented SI practices was low, the frequency of use of SI practices increased more with higher intrinsic motivation than in the other districts (Table S6).

5. Discussion

The role of motivations in decision-making on the use of SI practices and other new farm techniques and technologies by farmers has been recognised and studied (Adams, 2005; Gorton et al., 2008; Meijer et al., 2015; Paulrud and Laitila, 2010). However, many studies on adoption, adaptation and diffusion of innovations have not fully incorporated the concept due to the practical challenges associated with measuring farmers' motivations. As such, research attention is often diverted to

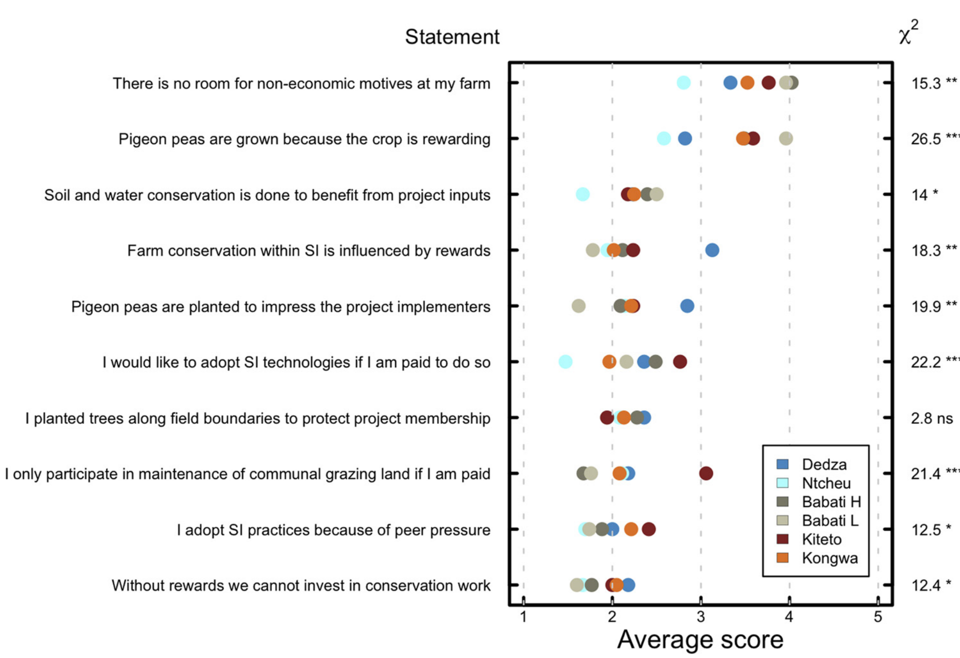

Fig. 6. Scores for statements on external motivation of farmers from Babati, Dodoma and Malawi for implementing SI practices based on a Likert scale (1 = strongly disagree, to 5 = strongly agree). PP and AR are acronyms for pigeon peas and Africa RISING respectively. The Kruskal Wallis test compares the farmer ratings across the study districts.

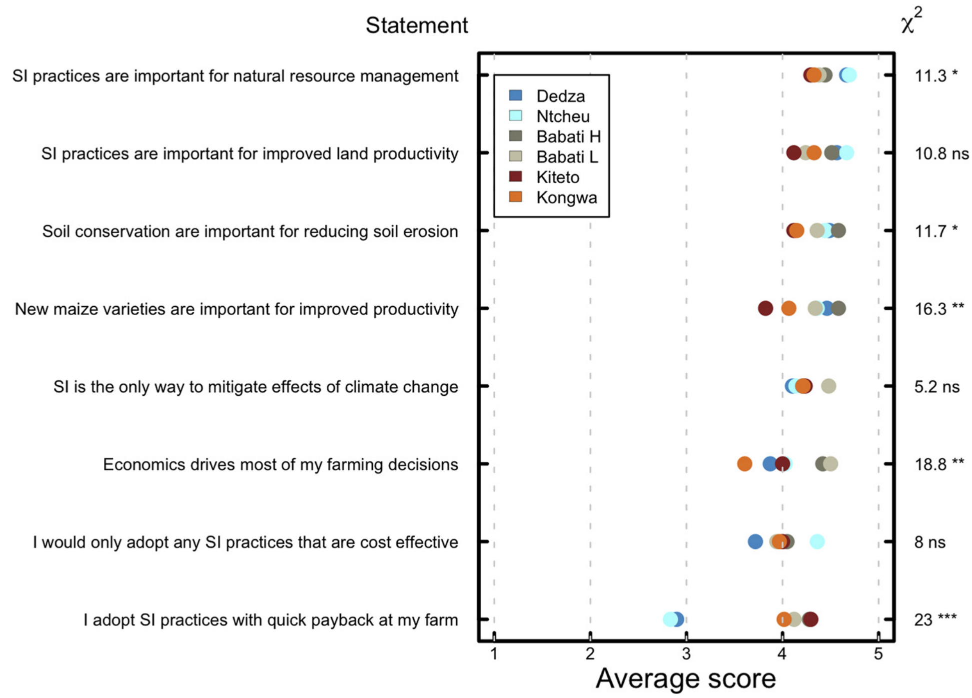

Fig. 7. Scores for statements on identified motivation of farmers for implementing SI practices based on a Likert scale (1 = strongly disagree, to 5 = strongly agree). The Kruskal Wallis test compares the farmer ratings across the study districts.

measuring farmers' characteristics which is less complex and more consistent (Meijer et al., 2015). Our study findings demonstrated that the use of SI practices by smallholder farmers in Tanzania and Malawi was positively influenced by both intrinsic and extrinsic motivations. Farmers' decisions were not exclusively dependent on external incentives, but also on intrinsic values which are attached to farmers' production resources, as previously observed by Greiner and Gregg (2011). Incorporating the motivational dimension of farmers' decision processes (cf. Fig. 1) in the implementation of SI projects might induce a change in the management of natural capital and reinforce SI of smallholder farms.

We observed a positive relationship between external motivation and the number of SI practices used (Table 5). This result signifies the current operational model of numerous agricultural projects. Extrinsic motivation is often regarded as basic, effortless and persuasive. As such, many project implementers use external rewards to persuade farmers to adopt sustainable agricultural practices (McRoberts and Franke, 2008; Mensah et al., 2012; Susilowati, 2014). Nevertheless, these incentives

Table 5
Significant terms in the stepwise multiple regression analysis for the number of implemented SI options (dependent variable).

Variable	DF	Sum of squares	Contribution to r^2	F-value	P-value
District	5	244.2	20.9%	24.5	$P < 0.001$
Land endowments	2	18.2	1.6%	4.6	$P < 0.05$
Project participation	1	170.5	14.6%	85.6	$P < 0.001$
Constraints	1	96.0	8.2%	48.2	$P < 0.001$
Intrinsic	1	34.5	3.0%	17.3	$P < 0.001$
Identified	1	53.2	4.5%	26.7	$P < 0.001$
External	1	15.3	1.3%	7.7	$P < 0.05$
Crop diversity	1	34.1	2.9%	17.1	$P < 0.001$
Food expenses	1	16.4	1.4%	8.3	$P < 0.01$
District x Intrinsic	5	40.4	3.5%	4.1	$P < 0.01$
Residual	227	445.9			
Total	246	1168.7	61.8%		

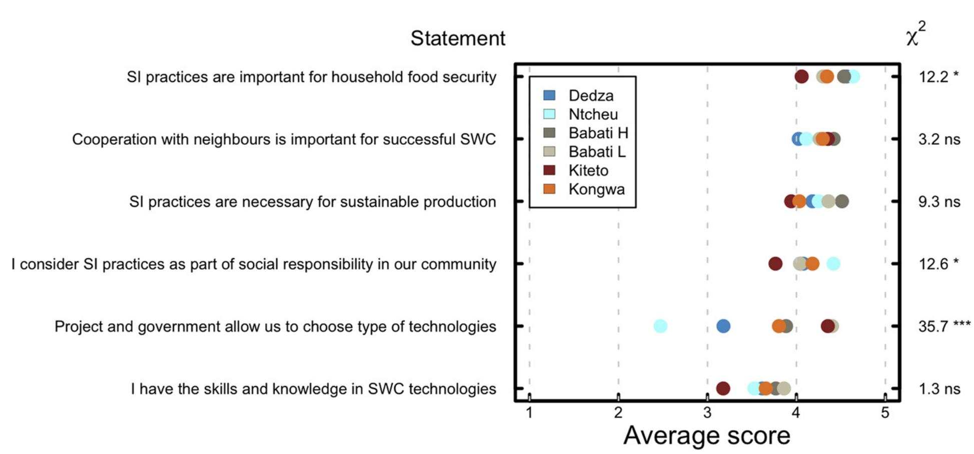

Fig. 8. Scores for statements on autonomy, competence and connectedness of farmers for implementing SI practices based on a Likert scale (1 = strongly disagree, to 5 = strongly agree). The Kruskal Wallis test compares the farmer ratings across the study districts. SWC: soil and water conservation.

direct farmers' attention towards rewards rather than to the intervention itself (Moller et al., 2006), and its adaptation and fine-tuning, which may compromise the sustainability of the implemented intervention in the long run. Our results indicate that increased internalisation could be reached by strengthening the autonomy and competence of the farmers, and their connectedness to the socio-institutional environment (Moller et al., 2006; Stobbelaar et al., 2009).

In the surveys and focus group discussions, farmers mentioned financial constraints as an important limitation for implementing SI practices. Lipper et al. (2014) indicated the need to link sustainable agricultural projects and financing. This is important because various SI practices require initial capital investment to purchase various inputs (e.g. fertiliser, improved seeds), postharvest technologies (e.g. Purdue Improved Crop Storage (PICS) bags) and to pay labour costs for labour-intensive innovations (e.g. Fanya Juu Fanya Chini -terraces made by digging a trench). To overcome these constraints, financial arrangements such as soft loans and other support services to farmers could play a role.

The frequency of use of SI practices differed across different case study sites. These sites were characterised by contrasting socio-economic conditions (Table 1; Fig. 3), which might have influenced the attitudes farmers had towards certain techniques and technologies. However, despite large socio-economic variation across the study regions, our regression analysis did not reveal any significant relationships between socio-economic variables and the use of SI practices (Table 5). Other differences among the districts may have been more decisive for adoption. For example, the number of SI practices used was lowest in Kongwa, where the perceived constraints to adoption, and in particular financial constraints, were strongest. Compared to other districts, the use of SI practices in Kongwa was more strongly related to intrinsic motivations. Moreover, the average number of local and modified innovations was larger than externally proposed practices which might indicate a close link between intrinsic motivations and the use of local and modified practices.

Our analysis revealed mismatches between some implemented SI practices and farmer expectations. The opinions of smallholder farmers are often forgotten when packaging interventions to support SI, resulting in a low-level acceptance of proposed innovations (Bekele, 2007). Indeed, most of the innovations that were demanded by individual farmers in Tanzania, such as irrigation farming, green manure, composting, modern storage facilities, specific varieties of beans and rice farming, were not promoted by the project. Similarly, in Malawi most of the farmers were poor. As such, their focus on SI was diverted by other immediate financial and food security concerns. A participatory inventory of farmers' attitudes and priorities as the basis for the selection of SI innovations to be promoted, could alleviate the mismatch between farmer priorities and R4D project focus. Apart from these mismatches, we further observed during discussions with farmers and key informants that security issues related to land ownership prevented certain households in Malawi to consistently take part in the implementation of SI practices.

Sustainable farming focuses on social equity and sound environmental management along with economic viability of farms (Peterson et al., 2012). Acceptance of sustainable agricultural practices requires moral and social concerns to be taken into account besides the strong economic concerns (Mzoughi, 2011). Using a decision model which integrated profit maximization and environmental management motives, Chouinard et al. (2008) found evidence that some farmers are willing to sacrifice some profit to engage in environmental stewardship which is a sign of strong intrinsic attachment to their farms. As such, policies that support intrinsic and extrinsic motivations of farmers can be effective in stimulating the shift from high input-intensive agriculture to more sustainable agricultural practices which are grounded on agroecological principles (Dobbs and Pretty, 2004; Mateo and Ortiz, 2013).

Our study focused primarily on the perceptions of individuals on the advantages and disadvantages of SI practices and on their intrinsic and extrinsic motivations. Less attention was given to deeper analysis of social relations within the farmers' communities and the relations with institutions, which can both influence the connectedness that farmers experience, and thus the level of internalization of behaviour regarding sustainable intensification of farming. Perceived social support can increase farmers' levels of achievements by stimulating their attitude towards experiential learning around new agricultural innovations (Cirik, 2015; Ariani, 2017). Moreover, implementers who choose their actions autonomously while being strongly connected to others are more prone to adopt values or behaviours of the group they belong to, and function with mutual interests in mind (Chirkov et al., 2003). This is of crucial importance for the effectiveness of community-level sustainable intensification initiatives (e.g. implementation of soil and water conservation structures or agroecosystem restoration and erosion mitigation) that are designed to address problems that surpass the field and farm scales (Stobbelaar et al., 2009). Follow-up studies could analyse relations with the socio-institutional context in more detail, for instance employing social network analysis.

6. Conclusion

To stimulate economic viability, improve nutrition, reduce poverty and hunger and safeguard the natural resource base of rural economies, understanding is required of what motivates smallholder farmers to implement SI practices. Our results indicated that farmers use more SI practices with an increase in both intrinsic and extrinsic motivations. Despite socio-economic variations which influenced agricultural performance across the study sites, farmers perceived agriculture and SI as ways to strengthen their livelihoods in all the research sites. Yet expected benefits from SI were concealed by risk aversion, and constraints in the availability of labour, capital and land. While motivation theory values intrinsic motivation to be more important than extrinsic motivation in driving decisions to use innovations, our results suggest both intrinsic and extrinsic motivations as equally important in the implementation decisions of smallholder farmers. As such it would be useful to incorporate both intrinsic and extrinsic motivations in further research together with social, economic and biophysical variables to give a true reflection of what drives acceptance of SI practices. We argue that the design of SI research programs should support motivations of farmers from diversified social classes for SI related techniques and technologies. Supporting farmers' autonomous choices can stimulate ownership of SI projects and smoothen implementation and innovation processes by farmers. This might reduce a mismatch between externally proposed innovations and farmers' expectations.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.njas.2019.100306.

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