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Identifying crop productivity constraints and opportunities using focus group discussions: A case study with farmers from Tigray

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ABSTRACT

Crop productivity in many places in Sub Saharan Africa is low. This affects food security and rural livelihoods. Identification of constraints and opportunities is a first and essential step in development processes aiming at improving crop productivity. Macro- and meso-level diagnostic methods frequently point to soil fertility and agronomic practices as major constraints. In Tigray, our study area in Northern Ethiopia, we applied focus group discussion in four locations to identify productivity constraints and opportunities. Outcomes in the form of "mind maps" were quantified to allow comparison between the locations. We found that, apart from some similarities, outcomes demonstrated much diversity. Location specific conditions and agronomic factors were considered main constraints by farmer groups in all locations. Soil fertility measures were considered a main opportunity. However, other categories of constraints and opportunities, like economic factors and irrigation, were diverse for the locations involved. Observed outcome variability was supported by descriptive biophysical and socio-economic data. We concluded that superficial identification of constraints and opportunities neglected contextual diversity. Making such diversity visible is essential in understanding and addressing this complexity. Applying approaches like focus group discussion, therefore, offers important opportunities at grassroots-level to give farmers a mandate and responsibility at early stages of development processes.

1. Introduction

1.1. Identification of crop productivity constraints

In Sub Saharan Africa (SSA) a majority of the rural livelihoods depends on subsistence farming based on low external input systems. These systems face major challenges in relation to productivity, which is often low, and sustainability, which is in many cases questionable. Low productivity and lacking sustainability have a pronounced negative impact on development of involved livelihoods.

Tigray, in northern Ethiopia, is an example of an area with livelihoods based on such systems. Here, low crop productivity results in food insecurity and a high vulnerability [1]. In most households no surplus of food will be available and even during normal rainfall years around 40% of the farm households structurally depend on food aid (pers. com staff Bureau of Agriculture and Rural Development). Food aid in such cases might have become part of the livelihood strategy of farmers, as is also described by [2] for other parts of Ethiopia.

Identification of crop productivity constraints and relevant opportunities are very important to design interventions aiming at improved agricultural productivity and, related to that, improved livelihoods. Constraints can be identified at different scale levels. At higher scale levels, for example, [3] indicated that for SSA nutrient-deficiency is a major constraint and responsible for yield gaps. Also [4] identified nitrogen-deficiency, together with limited access to fertilizers and seeds, weeds and diseases as important constraints for African Temperate Highlands. In line with this the Sasakawa Global-2000 program, which relied on addressing productivity constraints, forwarded a strategy based on the Green

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Revolution mantra of improved varieties and fertilizer application for Ethiopia in the 90′s [5,6].

At lower scale level, an analysis based on descriptive data for Tigray revealed that, in contrast to our expectations, rainfall in the region seemed adequate enough to support crop production but that soil-nitrogen level in most cases was low [7]. Farm management was observed to be traditional and only limited external inputs were used. This led to the assumption that limited availability of soil-nitrogen and a low management level were important productivity constraints.

These are three examples of diagnosis that resulted in a predictable set of non-specific constraints, i.e. water, nutrients and management, having no relation with complexity at the local level. Arriving – based on the above constraints – at "*best fits*" for intervention [8], consequently, is challenging.

In addition, the diagnostic methods referred to above, are criticized because they tend to ignore farmer knowledge and preferences, resulting in non-effective interventions and limited adoption of proposed technologies [9,10]. In response to this lack of impact, participatory methods are advocated to generate data at grassroots level, to address livelihood complexity [11–13] and to achieve empowerment [14]. However, participatory approaches often yield qualitative insights which complicates analysis and reporting [15,16].

Participatory approaches are assumed to be essential [14,17] in relation to achieving change. To evaluate the effectiveness of participatory approaches we developed a research project focusing specifically on participatory experimentation in the context of low external input agriculture. In relation to effectiveness we considered various technical and social outcomes (like recommended practices, novel agricultural management and empowerment). An important point of departure in our research project was to delegate as many responsibilities as possible to participating farmers in order to achieve a collegial type of participation [18]. Following such a mandate, farmers were to be involved in all phases of experimentation, including problem identification.

Participatory approaches are diverse and their selection depends on objective and context. Examples range from mapping and ranking exercises to developing calendars and diagrams, transect walks and role-plays [14,19]. Within the context of our research project in Tigray we used one of these approaches, focus group discussion (FGD), to identify crop production constraints.

FGD is a specific participatory method that combines the aspect of working in groups with that of groups being in control of the process [20]. By using FDG we aimed to arrive at insights relevant for the specific context of the groups involved as well as to achieve some degree of empowerment. In addition, FGDs allowed us to involve farmer groups as much as possible in all experimental phases.

1.2. Focus group discussion

In FGD a group of participants discusses specific issues. It is a popular method to collect relatively large volumes of information in a relatively short time. This information contains different forms of cognition expressed by the groups involved, like, for example, experiences, perceptions, insights and opinions.

In FGDs, opinions of individual participants are converted to a more or less shared group opinion. Process factors related to group interaction like negotiation, presence of networks, power relations, knowledge generation and learning processes [21] are, next to cognition, essential components of a FGD. The associated group interaction is assumed to provide a certain level of content validity of the generated information [22]. Ideally, participants in FGDs control the discussion and collection of information [20]. In specific conditions this control can even be expanded to settings in which participants bear responsibility for the identification of the topics of the discussion and its final analysis and interpretation.

Analysis of FGD-outcomes is often a relatively arbitrary and time consuming exercise [16,23]. These outcomes typically are "rich and innovative" [16] and examples, next to transcripts, video-recordings and notes taken [15] are also physical products like "mind maps" and "rich pictures". Reporting, interpretation and use of outcomes in a more comparative way is often complicated. Analysis of outcomes by outsiders is difficult and its richness cannot always be exploited. The knowledge involved in such cases, may not become fully explicit. In general, documented experiences at lower scale levels, indicating how these outcomes are translated into priorities and related interventions are relatively limited. Examples can be found in the context of participatory plant breeding (e.g. [24]). All in all, using FGD means embarking on open processes with valuable and rich outcomes that require careful analysis of outcomes to allow meaningful implementation in development context.

1.3. Research objectives

In this paper we used the results of these FGDs to discuss its potential in relation to the design of interventions to support local people in their livelihoods. We analyzed a series of FGDs with farmers aiming at constraint and opportunity identification in four locations in Tigray. In addition, we described and discussed the systematic procedure we developed, allowing us to compare the four communities involved. In relation to this we identified the following objectives:

- Identifying which constraints and opportunities the farmers involved perceived and how these compared to the (macro-level) outcomes of more general approaches.
- Reflecting on process and procedures involved in conducting and analyzing FGDs.

2. Material and methods

2.1. Study area

In Tigray four *woredas* (sub-regional administrative units) were involved: Werie-Leke, Hawzen, Ahforom and Dogua Tembien (Fig. 1). In this study we used the names or abbreviations of their respective administrative centres to indicate them: Edaga Arbi (EA), Hawzen (HW), Inticho (IN) and Hagere Selam (HS). Smallholder subsistence farmers, using limited external inputs represented the main part of the agricultural population. Farm size, in general, did not exceed 0.75–1.0 ha and, given the low yields obtained, many farmer households are food insecure. Altitude in the study area varied between 1900 and 2600 m above sea level. Rainfall depended on altitude and orography and was erratic and highly variable [18,19].

The four *woredas* were selected based on a brief assessment of their typical characteristics (Table 1): Edaga Arbi representing a somewhat isolated area and as such typical for many remote locations in Tigray, Hawzen representing a typical drought-prone area with much activity of Non-Governmental Organizations (NGOs), Inticho representing a more developed area with abundant small-scale irrigation activities present and a good access to markets and finally Hagere Selam, which is a relatively cool highland area with high rainfall and much NGO-activity.

The selected *woredas* showed distinct differences with respect to development intervention history. Between 1975 and 1990, Edaga Arbi was located in a war-zone and exposure to development activities by NGOs and extension, consequently, was very limited. After 2000, especially in Hawzen and Hagere Selam, NGOs were

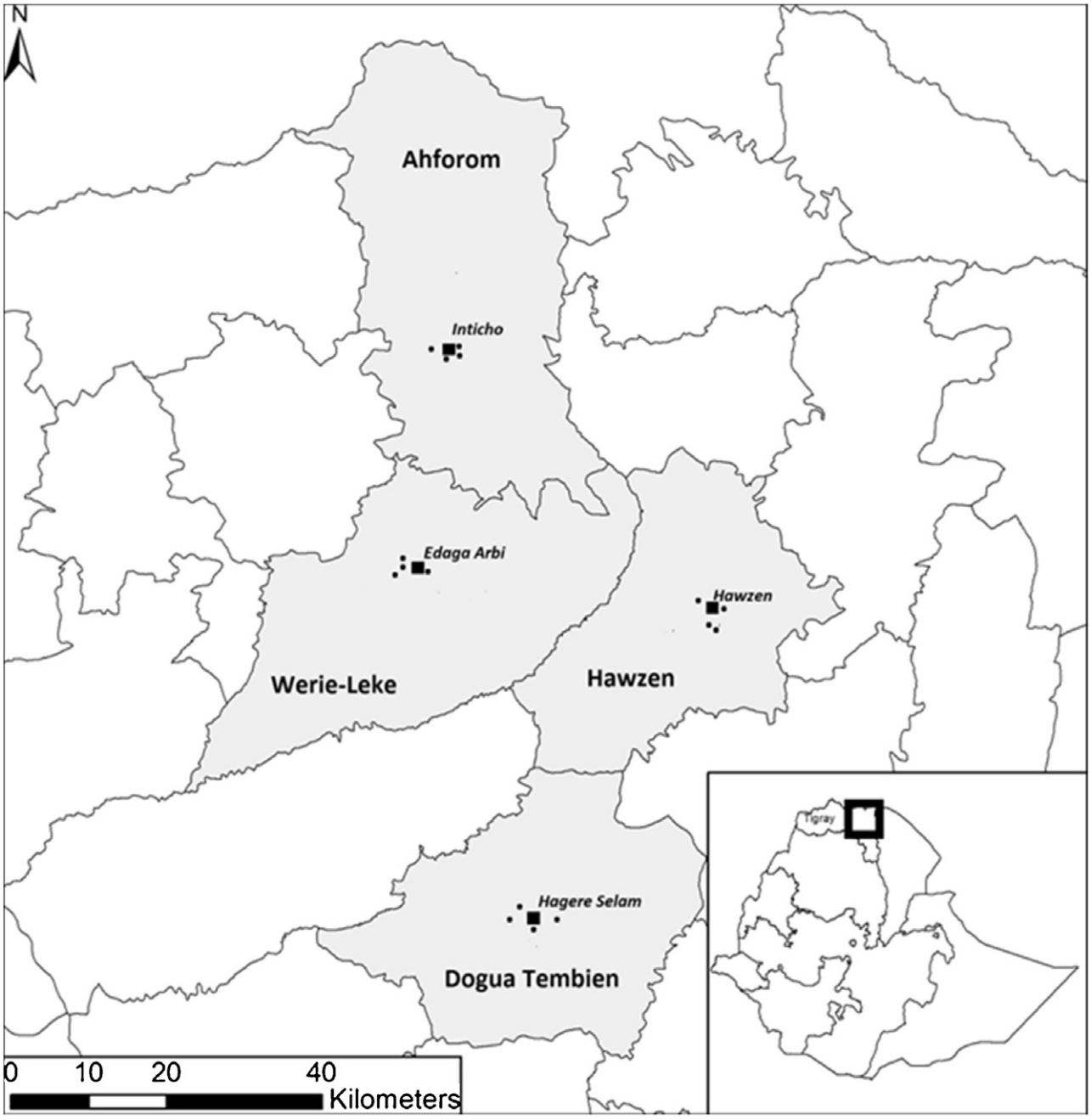


Fig. 1. Location of the study area and the involved locations (*woredas*) in Tigray, northern Ethiopia (rectangles refer to administrative centres, dots to the locations of the *cushets* involved).

Table 1
Relative estimated importance of specific concerns for the four different study locations. Estimations by the first author, based on field observations and interviews (BoARD = Bureau of Agriculture and Rural Development, EA = Edaga Arbi, HW = Hawzen, IN = Inticho, HS = Hagere Selam).

Concern	Estimated importance
	Low----------Medium----------High
NGO and BoARD activity	EA----------HW----------HS/IN
Irrigation	EA----------HW/HS----------IN
Fertility	HW----------EA/IN----HS
Drought	HW----------EA----------IN----------HS

strongly involved with development activities, in Inticho the local Bureau of Agriculture and Rural Development (BoARD) actively promoted novel technologies to increase crop productivity.

At *woreda*-level BoARD is responsible for planning and organization of development activities and specialized experts, for example, deal with livestock or watershed management. *Woredas* are divided into *tabi tabias* (villages) which again are divided into *cushets* (neigbourhoods), the lowest administrative level. Development activities are implemented at *tabia*-level, for example, in the form of Farmer Training Centers (FTC's). In these FTC's the offices of development agents are located and often also demonstration facilities and fields are present.

Descriptive data, based on individual surveys (n = 21 for each location) in the involved *tabias*, demonstrated considerable differences between the locations with respect to holding size, livestock number, farm-family ratio and use of fertilizers (Table 2).

2.2. Procedure FGD

Four FGD-workshops with farmers were conducted from November 2008 to February 2009, one in each *woreda* selected. The topic of these workshops was crop productivity and our objective was to explore farmers' perceptions of related constraints (problems) and opportunities (solutions). Crop productivity was selected since our research on effectiveness of participatory experimentation was conducted in the context of low external input agriculture. The identification of constraints and opportunities by the farmers involved in participatory experimentation was an essential first step in the participatory process envisaged.

The selection of participants was based on using key-informants (see Ref. [25], i.e. FTC-staff at *tabia*-level, who supplied names of farmers who were: (1) assumed to be interested and willing to participate in a process of joint experimentation and (2) came from the same *cushet*. FTC-staff categorized these potential participants as active farmers that in many cases had been engaged before in research activities. In each of the *cushets* five farmers were approached personally to request their participation in the workshops.

In the FGDs cognitive inputs other than that of the participant-farmers, were avoided as much as possible. For example, we did not allow BoARD-staff to participate and restricted our personal involvement to process matters like facilitation and moderation. Our ambition was, in line with [12], to delegate responsibilities as much as possible to the farmers.

Commitment of the farmers was high: only one out of about 80 farmers invited excused himself for medical reasons. A majority, about 75%, of the farmers participating was illiterate. The workshops, all with the same female moderator, were held in meeting halls or offices of BoARD. In each of the workshops around 20 farmers participated in four *cushet*-based groups (each of about five farmers). FGD in our case can be considered an expert panel-FGD, farmers being extremely knowledgeable with respect to livelihood-issues.

2.3. Construction of mind maps

In the workshops the moderator presented three central questions to the farmers, which were the basis for the construction of the final mind map:

1 What are important issues related to crop productivity?
2 To what extent/degree do these issues have impact on crop productivity?
3 How and to what degree are these issues related?

These questions respectively related to identification, prioritization and addressing complexity. Each of these question was dealt with in specific sessions, interrupted by tea and lunch breaks. In the first part of each session, the question concerned was discussed by the members of the *cushet*-based groups, in the second part of a session these groups contributed to the preparation of the "mindmap" (Fig. 2).

After informing participants on the context and objectives of the workshop the moderator explained the first central question. Farmers discussed this question in their group and a spokesman made notes on the outcomes. All four groups orally reported their findings through their spokesman and all issues that, according to them, related to crop productivity, were noted on a map. By using colours, it remained clear which group had contributed a specific issue. In case a group referred to an issue already mentioned by another group, their colour was added. In this way the map represented all identified issues for all four groups. At the same time, the

Fig. 2. Farmers from Inticho adding their findings to the map.

Table 2
Descriptive data of the four locations (TLU = Tropical Livestock Units, standard deviations between brackets, survey data are based on n = 21 for each location).

Variable	Location			
	Edaga Arbi	Hawzen	Inticho	Hagere Selam
Farm size total[a] (ha)	1.04 (0.55)	0.89 (0.63)	0.68 (0.35)	0.83 (0.41)
Household size[a] (persons)	6.43 (1.96)	6.67 (2.15)	6.95 (1.88)	6.48 (2.16)
Farm-family-ratio[a] (total ha/person)	0.16 (0.07)	0.13 (0.09)	0.1 (0.05)	0.14 (0.10)
Hiring-index[a] (% hired/total land)	39.21 (24.44)	17.98 (22.08)	23.59 (24.56)	21.67 (23.94)
Fertilizer use-index (kg/ha)	90.66 (61.18)	102.15 (60.02)	135.37 (96.91)	50.48 (46.54)
TLU[a] total/farm	3.31 (2.09)	2.86 (2.35)	3.09 (1.26)	2.44 (1.73)
Average rainfall (mm/year)[b]	742	522	742	683
Mean minimum temperature (°C)[b]	12	10	12	11
Mean maximum temperature (°C)[b]	27	27	27	23
Parent material[c]	Shale, basalt	Shale, sandstone	Basalt	Basalt, shale, sandstone, limestone
Altitude range (m)[c]	1950–2200	1950–2100	1959–2100	2300–2600
Soil types[c]	Cambisols, Vertisols, Luvisols	Cambisols, Vertisols	Cambisols, Luvisols	Vertisols, Cambisols, Phaezems

[a] Census data based on individual surveys, conducted 2009 in the *tabias* involved (see Ref. [38]).
[b] Adapted from Ref. [39]; rainfall for 1991–2008, temperature for 2008.
[c] Biophysical data: observations by the first author.

outcomes presented were discussed among the participants and questions were raised. This session took about two hours.

In response to the second central question, the groups were requested to attach, using their colour, a weight to each of the issues on the map they considered relevant. They were allowed to use values from 1, 2 or 3, using + or − for respectively a positive or negative contribution to crop productivity. In case they did not consider an issue relevant they left it blanc. After the discussion in the groups again spokesmen of all four groups presented their findings and added, using their colour, numbers to the map. During this session, which again took about two hours, groups reacted also on issues raised by other groups.

For the third central question, farmers were requested to discuss the relations between the issues on the map and the weight of these relations. In each workshop we used the same examples to highlight this specific question: (1) the (inter)relation between population and farm size and (2) the (feedback)relation between productivity and fallowing. After discussion in their groups issues were connected by using arrows, and numbers were added by either the moderator or by a spokesmen, again using their group's colour. In this part groups reacted on each other and asked, for example, for explanation. Also this session took around two hours.

After about six hours the workshop closed with the moderator explaining that the complex "mind map" needed to be analyzed and by looking forward to the next phases of the participatory experimentation process.

2.4. Quantification of FGD outcomes

The original FGD-procedure, in our case producing a qualitative-visual "mind map", was extended with an additional step, in which the initial outcomes were quantified. This quantification was meant to support analysis [26] and to make the "mind maps" more instrumental in comparing similarities and differences for the four locations. To develop this additional procedure we used an iterative stepwise process that converted the raised issues and their attributed weights into radial diagrams.

Step 1: Translating and organizing data

After conducting the workshop the issues on the "mind maps" were registered in a spreadsheet that included frequencies and attributed weights. In a few cases, notably in the case of Edaga Arbi, the primary outcomes of the workshop had to be slightly adapted since some misunderstanding with respect to the signs of the weights had occurred.

Step 2: Categorization

Categorization was the necessary next step since the number of issues was unexpectedly high, up to 40 issues for one workshop. In the four workshops together a total 106 different issues were identified by the farmers and recorded on the maps. Many issues overlapped or differed sometimes only in word choice and appeared to belong to a shared domain, i.e. category. Therefore, categories were defined around broad concerns like shortage of assets (economic factors), constraining pests (agronomic factors) or contra-productive management (conservative management). This process finally resulted in twelve categories that allowed complete and transparent accommodation of the raised issues with a sufficient level of detail, coherence and similarity. Categories were divided into two main groups: constraints (= problems) or opportunities (= solutions). There were six constraint categories: demographic factors, agronomic factors, economic factors, conservative management, location specific issues and land related issues. The six categories referring to opportunities were: good management, innovative management, irrigation, soil and water conservation-measures, soil fertility measures and external factors (Table 3).

The categorization allowed us to transform somewhat diffuse qualitative data into more structured information allowing further analysis. Due to this categorization, information ("richness") is likely to get lost and at the same time foci might have shifted due to generalization. We tried to compromise this trade-off by defining categories ex post that, in line with [23], remained as close as possible to the issues that were forwarded by the participants, avoiding a merely academic perspective. For example, the application of fertilizers is supposed to boost productivity and, consequently, is an opportunity whereas its cost definitely is an economic constraint.

Step 3: Quantification

In the quantification procedure, frequencies of quotes (i.e. times of mentioning) for the issues within a category were used in combination with weights attributed. In this way not only the themes emerging from the discussion, but also the aspect of consensus [26] and priority were included in our quantification. This finally resulted in what we called *relative perceived impact*. To arrive at this *relative perceived impact* we used, in analogy with indicators like citation-index, the concerns of both frequency and attributed weight. Two indices, respectively *consensus-index* and *priority-index*, were introduced to represent them.

Frequency aspects were covered by the level of consensus farmers demonstrated during the FGD-workshops. The *consensus-index* for a specific category was calculated by dividing the total number of quoted issues by the number of different identified issues in that category:

$$\textit{Consensus-index} = \textit{total}\ \text{quotes in a category/identified issues (i)}$$

The maximum value for this *consensus index* of a category was four, in case all (four) groups quoted all identified issues.

The aspect of attributed weight was represented by defining the *priority-index*. To calculate this *priority-index* for a specific category we divided the (absolute) sum of all attributed weights in this category by number of times a weight was attributed by the groups:

$$\textit{Priority-index} = \Sigma\ \text{attributed weights/times of grading (ii)}$$

The maximum value for this *priority-index* was three, in case all groups attributed the maximum weight of three.

Both aspects, *consensus-index* and *priority-index*, were combined in an indicator for the perceived impact of a specific category on crop productivity. For this purpose both indices were multiplied:

$$\textit{Perceived impact} = \textit{consensus-index} \times \textit{priority-index}\ \text{(iii)}$$

To allow comparison of the perceived impact between the four locations, the maximum perceived impact was introduced. This maximum perceived impact depended on the number of groups that participated and was determined by taking the maximum for both indices. For Edaga Arbi, Hawzen and Inticho this maximum was 12, for Hagere Selam it was 9.

The relative perceived impact then was calculated as a percentage of the maximum perceived impact:

$$\textit{Relative perceived impact} = (\textit{perceived impact}/\textit{maximum}) \times 100\%\ \text{(iv)}$$

Table 3
Twelve categories of constraint and opportunities with in total 106 accommodated issues raised by farmers in the four FGD-workshops.

Category	Mutual concern	Issues
Conservative management	Contra-productive traditional management	wasting time, un-ability to construct well, no manure use, post-harvest losses, many cultural holidays, not taking care for trees, not growing many vegetables, using much food for celebrations, working without plan, not working hard, depending on governmental support, in proper use of credit, not adopting innovations practically, not using fertilizers, not using improved seeds, dated ploughing methods, not using compost, delayed ploughing, livestock destroying crops, incorrect method of sowing, not diverting flood to the land, incorrect use of fertilizer, not ploughing timely, incorrect ploughing method, not weeding, broadcast sowing, not using insecticides, delayed sowing, bad land management, not mixing fertilizer with manure
Agronomic factors	Constraining pests	weeds, *humodia* (a fungal disease), animal pests, caterpillars, Striga (a parasitic weed)
Land related issues	Relation with specific land qualities	absence of terraces, incidence of soil erosion, poor soil fertility, wet soil, ponding of the land
Location specific issues	General conditions	shortage of rain, natural disasters, fog, hail, delay of rains, absence of micro-dams, rain during harvest
Demographic factors	Shortage of land	small farm, absence of fallow, no crop rotation, high population pressure, absence of forest
Economic factors	Shortage of assets	absence of oxen, not having farm tools, expensive fertilizer
Good management	Traditional management supporting productivity	matching crop with soil type, timely weeding, timely ploughing and sowing, taking care for the crops, ploughing often, not spending food for celebrations, timely farm management, terrace maintenance, proper time use, crop rotation
Innovative management	Management requiring inputs	using credit, using improved seeds, correct sowing method, proper use of insecticides, using drought resistant crops, using selected seeds, loosening soil for vegetables/fruits, growing cash crops, growing suitable improved crops, growing vegetables/fruits, family planning, using insecticide, using improved varieties, improved seeds, availability of vegetable seeds
Soil fertility measures	Improving nutrient status of soil	using fertilizer, using compost, correct use of manure and fertilizer, proper handling of manure and fertilizers, incorporating crop residues, using manure and compost, cheap fertilizer, correct use of fertilizer, correct use of compost
SWC-measures[a]	Soil and water conservation	drainage of the land, green strips between the fields, terracing
Irrigation	Irrigation	dam construction, check dams, using ponds/wells, expanding irrigated land, construction of micro-dams, availability of plastic for ponds, using drip irrigation, flood diversion to the land, using diversion
External factors	No direct control by farmers	sufficient rain, peace, support development agents, resettlement of farmers

[a] SWC = soil and water conservation.

Step 4: Visualization

Radial diagrams for constraint—as well as opportunity categories for each of the location were constructed to allow systematic comparison between the four locations.

3. Results

3.1. Focus group process

In the workshops interaction took place between farmers and moderator, between the farmers in a group and between groups. The first author concentrated on observation and recording the process. In a few occasions he was involved in answering specific questions of participants, especially in case workshop questions were not clear for all participants and required additional explanation.

In general farmers demonstrated an active participation, discussions in the groups were calm and all farmers seemed to speak up, although some more than others. They left each other sufficient room for discussion and they rarely interrupted each other. Interaction of participants in general was polite, respect- and meaningful. The involvement of the female participants in the discussions in some cases was limited, however, this was not because of purposive exclusion by male participants. The form chosen, discussion in small groups of farmers, fitted very well with the way farmers in Tigray traditionally discuss matters of importance.

Farmers who were responsible for reporting mostly had a central role in the discussion. Being often the only literate farmer in the group, this spokesman in most cases gave the oral and written presentation of outcomes. In only a few cases the moderator made a written report of the outcomes of the groups. Both the literate spokesman and the support provided by the moderator were essential in dealing with the issue of illiteracy of the majority of the participants.

In case a similar issue was already reported by another group, discussion took place about differences between specific issues raised. In some, but not all, cases this resulted in merging of issues. Especially during this part farmers reacted on findings of other groups in the form of questions or supportive remarks. With respect to the second question, farmers were also allowed to attribute weights to the issues forwarded by the other groups, an opportunity they eagerly took and which further enriched the map.

The first question did not cause many difficulties. Sometimes it was not clear to the participants that they were allowed to mention "problems" as well as "solutions" related to crop productivity. The weighing exercise connected to the second question initially was not fully understood by all participants. Therefore, further explanation was provided either by other participants or by the moderator. The third question addressed relations between issues and was quite challenging for the participants. Since the number of issues on the map at that stage was very high, it was difficult for the participants to have a good overview. In addition, in most cases only few farmers actually could read the information presented on the map. Responses to this third question, therefore, were not very comprehensive and consequently were not included in our analysis.

In retrospect, especially the Edaga Arbi groups had difficulties with the exercises. Mentioning constraints did not pose any problem. However, mentioning opportunities and doing the weighing exercise was rather confusing to them. Fewer difficulties arose for them with indicating relations between issues. In the Hawzen workshop farmers considered the weighing exercise difficult but interacted very much during the presentations. The Inticho farmers worked in a concentrated way and seemed used to workshop settings. The farmers from Hagere Selam did not have many difficulties with the questions, they were attentive and very interested in the findings of other groups.

3.2. Mind maps and radial diagrams

The constructed "mind maps" of the four locations visually differed in number of indicated issues and relations between them (Fig. 3). For Edaga Arbi the number of identified (and different) issues was relatively low compared to the other locations; however, relations between issues were more pronounced.

The radial diagrams constructed showed differences between locations with respect to type and magnitude of perceived constraints and opportunities (Table 4). Edaga Arbi farmers perceived location specific issues as a main constraint category and considered soil fertility measures as a main opportunity. No other opportunities, except for innovative management, were indicated. Hawzen farmers perceived location specific issues as the most important constraint category but also indicated diverse constraint categories of minor importance. Both Inticho and Hagere Selam demonstrated a somewhat balanced output for both constraints and opportunities. Economic factors were not mentioned in Edaga Arbi and Hagere Selam and were considered minor in Hawzen and Inticho. The attention for soil and water conservation was limited in all locations except Hagere Selam.

In the following phases of our research project we reported our findings to the farmers involved and to staff of BoARD and local NGOs and found these confirmed. In the course of their participation in the research, farmers included different research topics but focused throughout on the issue of soil fertility [27]. In addition, we found that all groups stayed involved in the research project, which also pointed to relevancy perceived of the issues addressed [28].

4. Discussion

4.1. Relating outcomes and context

Outcomes for the different locations differed with respect to the type of constraint or opportunity and the magnitude of relative perceived impact of these constraints and opportunities. Triangulating our findings with available descriptive data and observations (see Table 2), we found this variability in many cases in line with these. For example, outcomes for Inticho and Hagere Selam pointed to demographic issues as being most important. This aligned with the observation that these locations scored relatively low with respect to farm-size (Inticho and Hagere Selam), farm-family ratio (Inticho) and to some extent hiring index. The Edaga Arbi-groups, unlike all other groups, did not consider improved crop management an important factor in achieving higher crop yield. This matched with the higher availability of land in Edaga Arbi, as expressed in a relatively high farm-family ratio, which allows expansion of area under cultivation rather than leading to intensification. The outcomes for three locations, Hagere Selam, Hawzen and especially Inticho, indicated a strong belief of farmers in irrigation as an opportunity. The active promotion of irrigation in these locations by BoARD and in the specific case of Inticho the presence of some rivers, the traditional links with markets and the past exposure to Eritrean irrigation systems supported this belief. In addition, the limited availability of land in Inticho also may explain the interest in intensification and the on-going development of small scale irrigation activities. Like many other farmers in Ethiopia [29], farmers from Edaga Arbi, Hawzen and Inticho appeared to consider soil erosion a long term risk as was reflected in the limited attention demonstrated for soil and water conservation. However, in Hagere Selam, soil and water conservation was considered relevant, which matched with the actual situation in Hagere Selam where its relatively intensive rainfall often leads to fatal short term flooding.

A common reservation with respect to FGD is that its outcomes might be influenced by coincidence. In our case, for example, the incidence of hail or severe drought at some moment preceding the workshop might have resulted in a shift of focus and, consequently, have influenced reproducibility. However, the fact that groups mention specific issues demonstrated that at that particular moment these where considered relevant. Conducting FGDs clearly means including temporal dimensions of context and this by definition will affect reproducibility.

4.2. Reflection on process and procedure

The workshops generally went smoothly and without severe complications and participants were very committed. The fact that participants were mostly illiterate and came from underprivileged communities did not have much impact on the process. Former experience of farmers with workshop settings, like in the case of Hagere Selam, also supported the process.

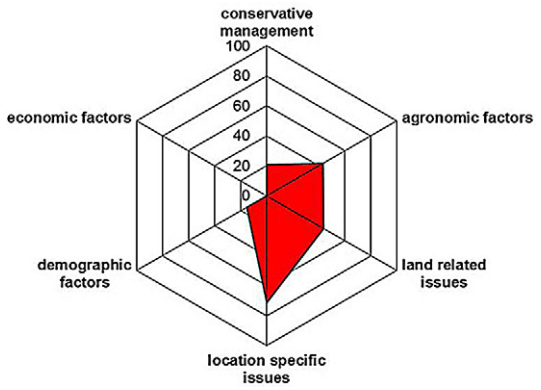
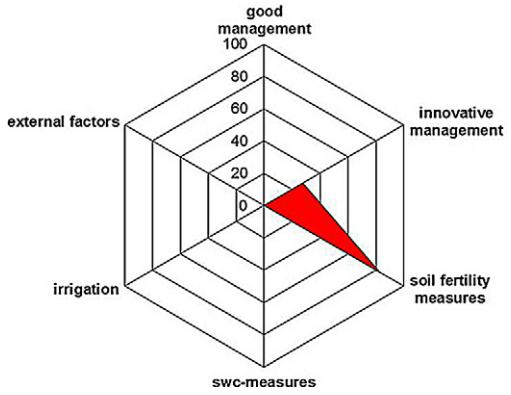
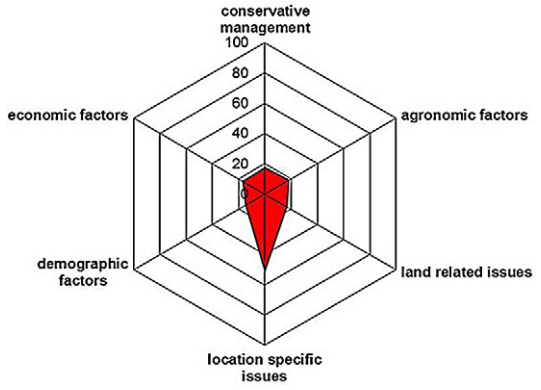
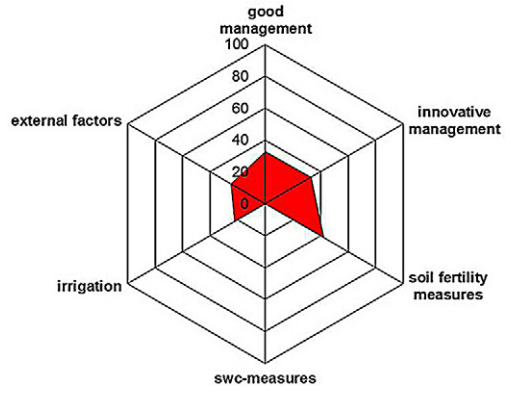
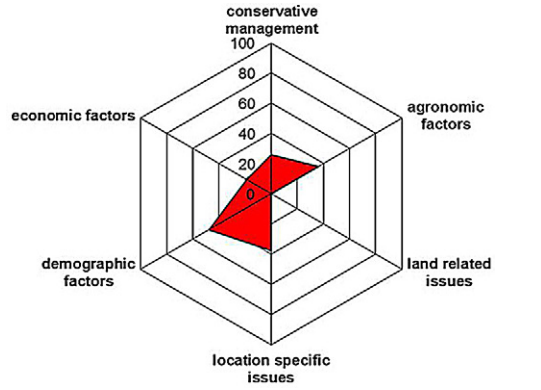
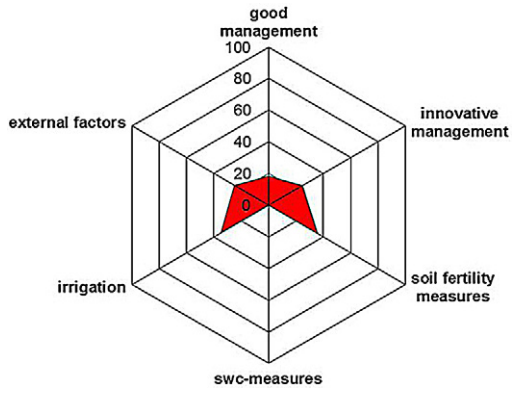
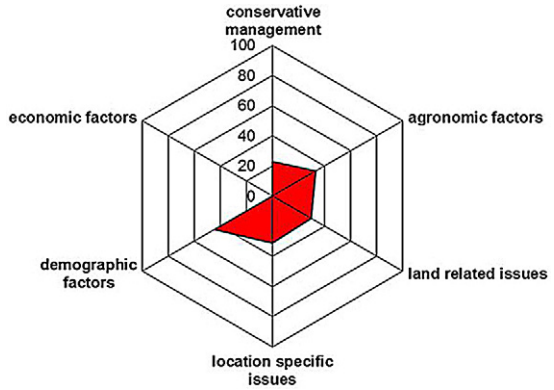
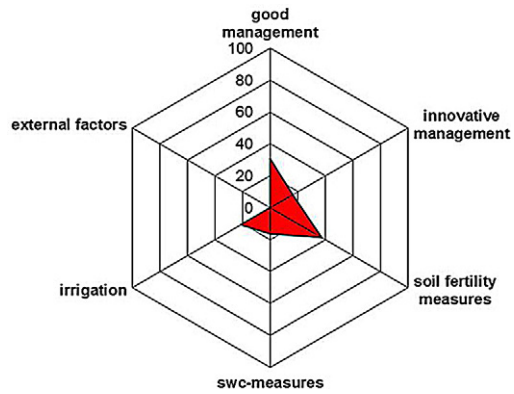
Explanation of the questions was sought by the participants, demonstrating self-confidence. The knowledge generated in the process was meaningful and appeared to represent shared opinions from the groups.

Common forwarded sources of bias in FGD relate to power relations between participants, for example through domination of individuals or groups [23,30]. As far as we observed, such dominancy, except for the central role of some spokesmen, was not taking place. In general farmers expressed a good feeling about their participation in the workshops.

The selection of participants is often mentioned as a decisive factor in affecting outcomes of FGDs [23]. In our case taking a simple random sample was not appropriate since participating farmers

Fig. 3. Mind maps prepared in the workshops in the four locations (from top to down respectively Edaga Arbi, Hawzen, Inticho and Hagere Selam).

Table 4
Radial diagrams showing *relative perceived impact* of constraints and opportunities on crop productivity for four locations in Tigray. *Relative perceived impact* is expressed as a% of the maximum (swc = soil and water conservation).

	constraints	opportunities
Edaga Arbi		
Hawzen		
Inticho		
Hagere Selam		

were expected to form groups with whom we intended to start a long-term process of experimentation and learning. Because of these preconditions we ended up with farmers who were all known to the FTC-staff and categorized by them as being potentially interested. Women were clearly under-represented, being only about 10% of the participants. The actual number of female headed households was estimated around 30%. Therefore, participants might not have been fully representative for the communities involved, in this way affecting generalizability. Another cause for biased outcomes often is an uneven distribution of wealth status, as pointed out by [31,32]. However, in our case its distribution appeared acceptable.

Although procedure development was not the actual objective of our study, we mostly made pragmatic choices, using four groups in one workshop turned out to be very effective. Merging them during plenary sessions allowed groups and individuals to react on the findings of others. At the same time the use of connected questions on the same topic allowed participants to reconsider their previous viewpoints. The workshops in fact were split into three parts in which a specific question was addressed. Each of these parts started with a discussion (a "true FGD") in small groups and was followed by a plenary discussion of all groups involved together resulting in the preparation of the final mind map. Designs using multiple focus groups are assumed to support verification of outcomes [26]. Communication and negotiation at different levels (in our case group and location) were used this way, in line with [23], as a point of departure to describe reality.

Quantification of the FGD-outcomes was a main feature of our case study. Our main objectives for this quantification were: (1) to support a transparent analysis that was to be reported back to the farmers participating in our research project and (2) to allow comparison of the four locations. Essential in our quantification approach were categorization and the combination of frequency and attributed weight. The categorization was very time-consuming and resulted in just above 10 categories, which we considered as an acceptable trade-off between level of detail and allowing overview. Although the use of frequencies in our quantification was very straightforward, the use of weights, on the contrary, implied that all groups involved used similar linear scales [33]. This was not the case and probably even impossible. However, the limited number of weights (three) and their later use relative to a location-specific maximum, might to some extent have compensated for these shortcomings.

In retrospect, the FGD-process and its quantification were divided into four main steps in which convergence or divergence of ideas and insights took place: (1) context and experience shaped ideas of individual farmers, (2) individual ideas merged into shared ideas of a group, (3) the opinion of the groups was represented by a mind map for their location, (4) issues presented on the map were categorized and based on this categorization translated into *relative perceived impact*. After these four steps these quantified findings were indeed confirmed by the groups involved (and by BoARD-staff) and then served as an input for the design of their experiments.

The experimental designs prepared by the groups were diverse and diverged; however, in all cases soil fertility measures had priority [27]. The observation that all groups continued experimenting [28] on the topic initially identified for four years, suggested that the groups kept on considering it relevant. Convergence took place in steps 1, 2 and 4. Some divergence took place in step 3 as well as in the experimental phase following constraint identification (Fig. 4). However, convergence was the main process and consequently loss of "richness" most likely had occurred. In addition, since the experimentation method used was not fixed, farmer groups again were able to diverge [27].

4.3. Relation with intervention work

Farmers experience a reality which is uniquely theirs and complex. The experiences and data we presented showed that farmer groups were well able to explore and identify local complexity. FGDs allowed the various contextual aspects, their interrelations and the way farmers perceived their reality to come out: the FGD-outcomes covered a wide range of constraints and opportunities and were indeed "rich and innovative" [17,23]. Local specific outcomes generated through FGD-processes, therefore, might be very relevant in tailor-made intervention work. For example, addressing soil fertility issues was likely to gain resonance in Edaga Arbi, but in contrast to Hawzen, Inticho and Hagere Selam and Inticho a focus on irrigation might be less justified.

The step by step transformation of the mind maps into radial diagrams was able to maintain local diversity. This demonstrated that the qualitative nature of FGDs did not necessarily obstruct a wider application among diverse stakeholders in intervention work. A thoughtful quantification of qualitative outcomes, as we and for example [15,24,33–36] presented, might support building interdisciplinary bridges between the different paradigms generally held by both social and natural scientists [14,36,37], bridges we consider essential for effective intervention work.

5. Conclusion

Intervention work aiming at developing agricultural productivity in low-external input settings requires an understanding of farmers' preferences and motivations and the complex socio-cultural settings in which these farmers operate. Macro- and meso-level constraint analysis generally cannot take local complexities and farmers' perspectives into account and instead identify broad general concerns like nutrient deficiency or drought as key entry points for interventions.

In our case study we identified, using quantified FGD-outcomes, different constraints and opportunities that demonstrated considerable local variation in type and magnitude. Apart from this unexpected diversity, outcomes from all locations referred to location specific and agronomic factors as major constraints. Economic factors only received limited attention. With respect to opportunities, participants overall considered soil fertility measures important. Macro and meso-level approaches generated similar outcomes in our context but logically cannot address small scale diversity.

The alignment of our quantified FGD-outcomes with the context observed and their confirmation by local stakeholders suggested that the procedure applied resulted in differentiated, relevant and valid outcomes. Therefore, FGD definitely has, given its ability to deal with complexity at small scale levels, an important potential to provide a useful foundation for intervention activities aiming at improvement of local farmers' livelihoods.

In addition, in our specific case FGD not only generated useful information, but at the same time served as an adequate starting point for the participatory research envisaged: FGD allowed empowerment of the farmers involved by giving them a mandate and responsibilities at the initial stages of the experimentation process.

We concluded that FGD was able to identify local perceptions and preferences which were made more explicit by a purposive quantification of its outcomes. Such a quantification not only might be relevant in supporting a more pronounced and meaningful use in context-specific intervention work but, in addition, also may serve

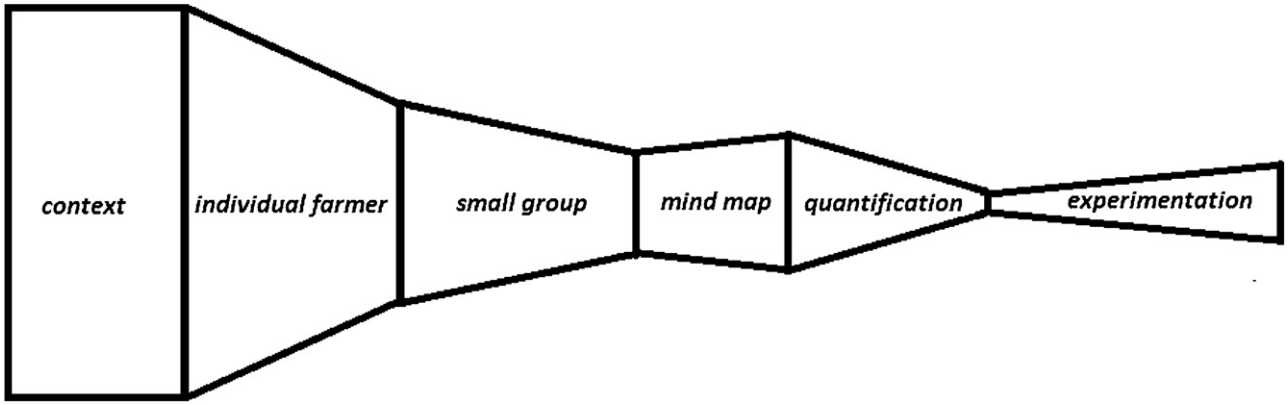


Fig. 4. Divergence and convergence taking place in different steps of our FGD-process (the vertical dimension reflects estimated richness of ideas and insights).

as a bridge between paradigms held by both social and natural scientists.

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