PhD-project: Investigating effectiveness of participatory approaches to improve crop productivity under low external input conditions in Ethiopia (PE&RC 08060)

PE&RC-08060-Working document III : Phase 1 (2008-2009 updated)

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Wageningen, 15-12-2015

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1-Introduction

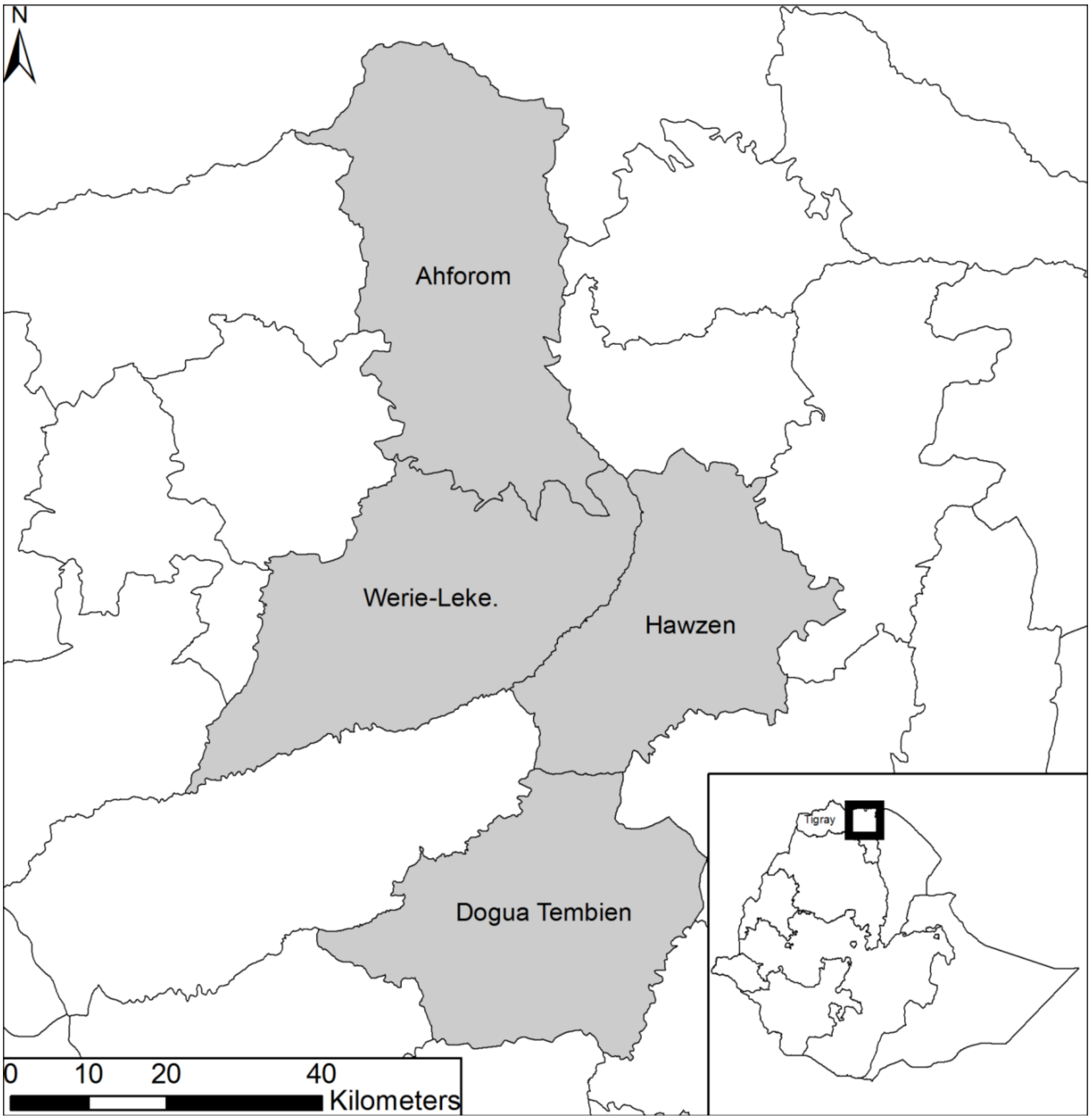
This document is based on Working Document I (see: http://edepot.wur.nl/259130) and extended with additional outcomes of the individual surveys conducted in Phase 1 (2008-2009) of our research project.

In Phase 1 information relating to farming systems, livelihoods and constraints was collected through interviews, workshops with farmers and collection of census-, soil- and weather data at different administrative levels (woreda and tabia). Additional a provisional procedure to quantify the qualitative data collected in workshops with farmers (focus group discussions) is provided. Next to this, based on our field-visits an area description, was compiled.

For evaluating congruency of the above mentioned approaches Spearman-ρ was used. The rankings used to apply this procedure are presented in two tables.

2-Area descriptions

Figure 1: Location of the study sites in central Tigray, northern Ethiopia.



Edaga Arbi (woreda Werie-Leke)

The landscape around the small town of Edaga Arbi (EA) is dominated by huge mesas resulting from volcanic intrusives and mesozoic shales, sandstone- and limestones. Soils found are vertisols, luvisols, regosols and cambisols depending on parent material and position in the landscape.

Erosion is a very serious issue due to the sensitive parent materials and the steep slopes present at many locations. Despite the fact that most areas are terraced and stonebunds have been constructed, erosion still isn't effectively under control. In line with the efforts taken to control soil erosion area closures are effectuated.

Irrigation is relatively recent in this area. In the western part a micro-dam has been constructed with a command area of about 100 ha. From one river water is used for irrigation by using motor pumps. Small scale irrigation structures like ponds, wells and diversions are very rare. In the Zonghi area agro forestry is important. Due to scarcity of land however this traditional systems comes under pressure.

During the civil war Edaga Arbi became isolated between Adwa, a main center of resistance, and the Hawzen area, dominated by the previous government. Due to this inputs like fertilizers became scarce and development and education came to a stand still. Older people claim that the level of development, especially in the form of education, was considerable in the period before the civil war. The only NGO active in Edaga Arbi at present is REST, mostly in relation to rehabilitation-activities.

Hawzen (woreda Hawzen)

Huge sandstone mountains within a pediplain-like landscape are characteristic for the Hawzen (HW) area. In the plain landscape various colluvial, alluvial and possibly glacial deposits are found. Main parent materials are sandstones, granites and shales. These parent materials result in a sandy soils or sandy clay loams. Since most soils are relatively young they can be classified as Cambisols or Regosols. The sandy soils are generally poor in nutrients but have a good infiltration.

In the past massive soil and water conservation structures have been realized with good success. In many places, due to the combination of terracing and a good infiltration, made the development of small scale irrigation structures possible. Due to the risen groundwater tables many households have successfully constructed ponds and shallow wells. Trees however are almost absent in this intensively cultivated area. Bottomlands are allocated for grazing.

Hawzen traditionally is an important market town. Some farmers therefore are involved in trade activities. Despite the growing importance of tourism off farm jobs still are very limited.

The area, which is notably drought prone, always received much development support from NGO's like Irish Aid, the Millenium Village Project and REST. Tabia- and cushet leaders are heavily involved in development activities.

Inticho (woreda Ahforom)

Around Inticho (IN) mesozoic shales and tertiary basalts are important parent materials that result in soils with high clay contents. In the alluvial plains soils tend to be sandy. Soils mostly have developed as Luvisols or Cambisols. In the hilly areas around Inticho erosion is serious and farmers use terracing to control it. Remote hills still have a reasonable coverage by bushes. Bottomlands are in some places used for grazing.

The presence of the mountain ranges promotes an early start of the rainy season allowing the successful cultivation of sorghum. Water from perennial rivers is traditionally diverted into the alluvial plains for the purpose of irrigation. At present big diversion structures have been realized.

Main NGO in the area is REST. Extension by the woreda BoARD is very active in supporting development. As irrigation knows a long tradition in this area supportive infrastructure in the form of trade and transport is quite developed. Inticho is a major center for the trade of cereals and was linked closely to Eritrea due to trade and education.

Hagere Selam (woreda Dogua Tembien)

In the area around Hagere Selam (HS) main parent materials are basaltic intrusives and mesozoic limestones, shales and sandstones. Depending on parent material and topography soils have developed as Vertisols, Phaezems or Luvisols. These are mostly soils with an high clay content and as a consequence of the low temperatures relatively an high organic carbon content.

A steep topography, long slopes and specific parent material in combination with a high rainfall results in a high hazard for soil erosion. To deal with this most of the land is terraced and protected extremely well by using stone-bunds in combination with grass strips and trenches.

Small scale irrigation is limited to a few suitable locations in which gully diversions are used to ponds. Vegetables and fruits for the local market are produced this way. Eucalyptus is grown for timber and serves for many farmer as a source of income.

Farmers sometimes find off-season employment in the nearby city of Mekelle. Hegere Salam received considerable attention from researchers studying various aspects of soil and water conservation in the framework of the IUC-project. Next to this some NGO's, like REST and the May ZegZeg project are active in development activities focusing on watershed management. Important spin-offs were the improving beekeeping, development of tree nurseries and the introduction of apple-trees.

3-Outcomes of individual surveys

Responses

Table 1: Descriptive data based on averages and standard deviations derived from the individual surveys in the period 2008-2009 (sd=standard deviation, TLU= Tropical Livestock Units).

		Total (n=84)	Edaga Arbi (n=21)	Hawzen (n=21)	Inticho (n=21)	Hagere Selam (n=21)
family size (persons)	average	6.63	6.43	6.67	6.95	6.48
	sd	2.02	1.96	2.15	1.88	2.16
hire-index (hired/total as a %)	average	25.45	39.21	17.98	23.59	21.67
	sd	24.68	24.44	22.08	24.56	23.94
total farm size (ha)	average	0.86	1.04	0.89	0.68	0.83
	sd	0.51	0.55	0.63	0.35	0.41
farm-family-ratio (total ha/person)	average	0.13	0.16	0.13	0.1	0.14
	sd	0.08	0.07	0.09	0.05	0.1
TLU* total/farm	average	2.92	3.31	2.86	3.09	2.44
	sd	1.9	2.09	2.35	1.26	1.73
fertilizer use index (kg/ha)	average	94.43	90.66	102.15	135.37	50.48
	sd	74.68	61.18	60.02	96.91	46.54

* bulls, cows, sheep, goat and donkey respectively count for 1.2, 1.0, 0.1, 0.1 and 0.3 TLU

Table 2: Issues mentioned in relation to crop productivity problems during interviews (% of total).

Issue mentioned as a problem	EA (%)	HW (%)	IN (%)	HS (%)	Sign.
Conservative management	0	0	0	0	-
Agronomic issues	19.3	22.4	42.5	41.5	P < 0.05
Demographic issues	28.1	10.3	21.9	15.1	P < 0.05
Economic issues	31.6	34.5	12.3	13.2	P < 0.05
Land related	5.3	6.9	8.2	7.5	
Location specific	12.3	19	8.2	20.8	
Other	3.5	6.9	6.8	1.9	

* One-way ANOVA on differences between woreda's.

Table 3 : Issues mentioned in response to the use of inputs and/or novel technology (% of total).

	EA	HW	IN	HS
farm tools	6.7	17.5		7.4
innovative management	26.7	15	38.5	18.5
soil fertility measures	46.7	47.5	36.5	37
swc-measures	2.2	0	0	0
irrigation	6.7	12.5	5.8	3.7
livestock	6.7	5	15.4	33.3
domestic	4.4	2.5	3.8	0

Table 4: Categorization of IS-responses on the use of inputs and novel technology.

Category	**Description**	**examples**
Obvious technologies	Technologies that were brought for a long time brought under the attention of farmers, Discussion or doubt seem a passed station. Implementation depends on available resources.	fertilizers, herbicides, pesticides, improved seeds.
Adjusted technologies	Technologies that are easy to achieve at a low cost. Farmers therefore can adopt them easily since they match with existing practice	compost, contour- ploughing, housing for livestock, hen houses, sowing in rows, growing vegetables.
new technologies	Technologies that require a considerable change of the farming system, a considerable investment or a considerable increase in knowledge.	Irrigation, well-construction, ponds, improved cattle, veterinary assistance, fruit trees, pumps.

4-Census-data

Table 5 : Census-data for farmsize, households and livestock (collected at tabia level).

tabia/woreda	Total area of land	total cultivated	land/farmer	Total population	Total farmers (HH	TLU-total
Machalawi (EA)	4422.5	852.35	0.556001305	8492	1533	5775.4
Endachaw (EA)	3495.95	1018.6	0.612876053	10458	1662	7350.3
Zonghi (EA)	3307	853	0.699180328	5835	1220	4187.7
Maykado (HW)	1652	616.1773	0.564264927	6809	1092	3152
Debrihiwot (HW)	5057	640.2	0.691360691	4583	926	2280.3
Siluh (HW)	1642.685	964.21	0.79489695	5535	1213	4342.2
Inda Mariam (IN)	2020	853.2	0.953296089	4574	895	
Mai Sru (IN)	1983	1070	1.165577342	5708	918	2304.8
Dibdibo (IN)	2408	1135	0.44649882	10443	2542	5747.3
Mikhael Adi (HS)	4918	1191.75	0.742061021	8027	1606	3764.8
Limeat (HS)	1158	550	0.468085106	5426	1175	2047.9
Aynbirkeken (HS)	8094	1570.4	0.830021142	8151	1892	5606.6
M-selassie (HS)	2545.8	567.8	0.539221273	4919	1053	2812.7

5-Biophysical data

Table 6: Soil data for selected fields in different tabias.

Site/woreda	year	soiltype	K-exch (mg/kg)	K-exch (mmol/kg)	P-olsen (mg/kg)	N-total (mg/kg)
Tikuz (IN)	2010	red luvisol (basalt)	72.8	1.9	13.1	760
Awadu (HW)	2010	sandy cambisol	201.3	5.1	27.8	560
Adigudat (IN)	2011	red luvisol (basalt)	419.4	10.7	47.2	1080
Zalaweni (HW)	2010	sandy cambisol	155.2	4	14.7	530
Zonghi (EA)	2011	red cambisol	69.3	1.8	15	860
Endamariam (IN)	2010	dark reddish luvisol (basalt)	597.4	15.3	48	1130
Munguda (IN)	2011	red luvisol (basalt)	264.6	6.8	27.7	1300
Adigudat (IN)	2010	red luvisol (basalt)	116.4	3	30.2	950
Mymisham (IN)	2011	dark cambisol	582.6	14.9	42.1	550
Biherawi (IN)	2011	dark cambisol	575.1	14.7	24.4	1310
Machalawi (IN)	2010	brownish cambisol	208.3	5.3	29.1	1180
Gudowro(HS)	2010	darl luvisol (basalt)	588.6	15.1	26.4	2040
Mymisham (EA)	2010	vertisol	461.2	11.8	39.6	1150
Adowro (HS)	2010	brownish cambisol	113.1	2.9	12.9	1270
Biherawi (EA)	2010	brownish cambisol	211.2	5.4	11	1040
Zonghi (EA)	2010	red cambisol	66.1	1.7	22.7	890
Adowro (HS)	2011	dark cambisol	451	11.5	39.9	1780
Hadishadi (HW)	2010	sandy cambisol	194.2	5	25	520

Munguda (IN)	2010	red luvisol (basalt)	332.5	8.5	18.7	1120
Adikolagol (HS)	2010	pheazem	442.7	11.3	40	1310
Dingelat (HS)	2010	vertisol	234.9	6	14.5	1490
Mayzagra (HS)	2011	loamy cambisol	60.4	1.5	20.8	920

Table 7 : Meteorological data (statistical analysis).

	EA	***HW***	***IN***	***HS***
Mean	921.75	536.1818182	676.8571429	837.0833333
Standard Error	170.352759	34.77089122	46.62996613	57.98268529
Median	925	517	648	848
Standard Deviation	340.705518	115.3219998	123.371294	200.8579137
Range	781	365	376	640
Minimum	528	325	469	518
Maximum	1309	690	845	1158
Count	4	11	7	12

6-Quantification of FGD-outcomes

Proposed procedure for quantification of FGD outcomes

In an iterative process a series of methodological steps was developed to provide quantitative expressions of the FGD-outcomes.

Step 1: Translating and organizing data

After conducting the workshop the charts were literally translated and outcomes were organized in spreadsheets indicating quoted issues, their impact and the type of relation between the issues.

Step 2: Categorization

Cross-sectional categories for the issues, exactly as indicated by the farmers, were prepared for the whole data set. Categorization was necessary since the number of issues was unexpectedly high, up to 40 issues for one workshop, and much overlap was present between the issues raised. The raised issues reflected either a negative or positive impact on crop productivity.

Categories were defined around more or less wide concerns like irrigation, soil fertility or economic problems. This process finally resulted in 13 categories that allowed complete accommodation of the raised issues with a sufficient level of coherence, similarity and transparency. Categories more referred to grass roots level then having an academic character.

Categorization resulted in constraint (problem) and opportunity (solution) categories. Constraint categories were: demographic factors, agronomic factors, economic factors, conservative management, location specific issues and land related issues. Categories referring to opportunities were: good management, innovative management, use of irrigation, swc-measures, soil fertility measures, fate, policy issues.

Table 8: Categories and accommodated issues.

Category	**Mutual concern**	**Issues**
Demographic factors	Shortage of land	small farm, absence of fallow, no crop rotation, high population pressure, absence of forest
Agronomic factors	Constraining pests	Weeds, humodia, animal pests, caterpillars, striga
Economic factors	Shortage of assets	absence of oxen, not having farm tools, expensive fertilizer
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
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
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
Location specific issues	General conditions	shortage of rain, natural disasters, fog, hail, delay of rains, absence of micro-dams, rain during harvest
Land related issues	Relation with specific land qualities	absence of terraces, incidence of soil erosion, poor soil fertility , wet soil, ponding of the land
SWC-measures	Soil and water conservation	Drainage of the land, green strips between the fields, terracing
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
Fate	No control by farmers	sufficient rain
Policy issues	Administration and governance	peace, support DA's, resettlement of farmers

Step 3: Quantification

In the quantification procedure, frequencies of quoted issues were used either as a single variable or in combination with an attributed priority.
The first option resulted in an indicator we called *"Importance"*, the second resulted, after a series of steps, finally in what we called *"Relative perceived impact"*.

Comparing the relative importance of individual categories can be done in a simple way by calculating the quoted issues in a category as a percentage of the total sum of issues quoted in the workshop:

*Importance = (quoted issues / overall sum of quoted issues)*100%* *(i)*

In order to include some concern of frequency and priority in our quantification we introduced two indices to represent them.

Frequency aspects are covered by the level of consensus farmers demonstrated during the FGD-workshops. This consensus-index can be calculated by dividing the number of quoted issues by the number of identified issues in a specific category:

Consensus-index = quoted issues / identified issues *(ii)*

Priority aspects are represented by an averaged priority. To obtain this average priority or priority index, the cumulative priority of issues in a specific category, is averaged by dividing it by the times grading was done:

Priority index = cumulative priority / times of grading *(iii)*

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

*Perceived impact =Consensus-index *Priority-index* *(iv)*

To make finally comparison of the perceived impact between the locations possible the maximum perceived impact is introduced. This maximum perceived impact depends on the number of groups that participated and is determined by taking the maximum for both indices. For EA, HW and IN this maximum is 12, for HS it is 9.

The relative perceived impact can be calculated as a percentage of the maximum perceived impact:

*Relative perceived impact = (Perceived impact/ maximum) *100 %* *(v)*

Step 4: Visualization

Radial diagrams for the problem- and solution categories for each location were constructed to allow comparison between the four locations.

7-Outcomes workshops

Table 9: Quantified workshop outcomes.

Category	**Relative perceived impact (%)**			
	Edaga arbi	Hawzen	Inticho	Hagere selam
conservative management	20.8	17.3	25.9	22.9
agronomic factors	43.3	18.3	36.3	33.3
location specific issues	71.4	50.6	37.5	31.2
land related issues	43.8	16.7	0	29.7
demografic factors	15.4	14.6	47.6	44.4
economic factors	0	16.7	18.8	0
good management	0	32.8	18.3	30.8
innovative management	27.8	33.2	24.7	16.4
soil fertility issues	83.3	42.3	35.7	37.4
use of irrigation	0	22.3	34.8	21.4
swc-measures	0	0	0	16.4
policy issues	0	0	25	0
fate	0	25	0	0

8-Comparison of approaches (using Spearman-ρ correlation)

Table 10: Attributed ranks for the selected topics for the three approaches (Rank 1= lowest, 2 = in between, 3 = highest).

	Approach	Topic	Rank			
			EA	HW	IN	HS
CONSTRAINTS	FGD	Conservative management	2	1	3	2
		Agronomic factors	3	1	2	2
		Location related issues	3	2	2	1
		Land related issues	3	2	1	2
		Demographic factors	2	1	3	2
		Economic factors	1	2	3	1
	IS	Conservative management	1	1	1	1
		Agronomic factors	1	2	3	2
		Location related issues	2	2	1	3
		Land related issues	1	2	3	2
		Demographic factors	3	1	2	2
		Economic factors	2	3	1	2
	CDC	Rainfall variability	3	2	1	2
		Nutrient deficit	2	3	2	1
		Land shortage	3	2	1	2
		Lack of assets	1	2	3	2
OPPORTUNITIES	FGD	Innovative management	2	3	2	1
		Use of irrigation	1	1	1	3
		Soil fertility issues	3	2	1	2
		SWC measures	1	1	1	3
	IS	Innovative management	2	1	3	2
		Irrigation	2	3	2	1
		Soil fertility measures	2	3	1	2
		SWC	3	1	1	1

Table 11: Attributed ranks for identified categories for the locations Edaga Arbi (=EA), Hawzen (=HW), Inticho (=IN) and Hagere Selam (=HS) for the approaches Focus Group Discussion (=FGD), Individual Surveys (=IS) and Contextual Data Collection (=CDC) (rank 1= lowest, 2= in between, 3= highest outcome). COMA = conservative management, AGRO = agronomic factors, LAND = land related issues, LOC = location related issues, DEM O = demographic factors, ECON = economic factors, GOMA = good management, INMA = innovative management, SF = soil fertility measures, SWC = soil and water conservation measures, IRR = Use of irrigation, POL = policy issues, FATE = fate related issues, FATO = farm tools, LST = livestock, DOM = domestic issues. NUTD = nutrient deficit, RADF = rainfall deficit, RAVA = rainfall variability, LSHT = land shortage, LASS = lack of assets.

FGD	constraints	issue	COMA	AGRO	LAND	LOC	DEMO	ECON	
		EA	2	3	3	3	1	1	
		HW	2	2	1	3	1	1	
		IN	2	2	1	3	3	1	
		HS	1	3	2	2	3	1	
	opportunitie	issue	GOMA	INMA	SF	SWC	IRR	POL	FATE
		EA	1	2	3	1	1	1	1
		HW	2	2	3	1	2	1	2
		IN	2	2	3	1	3	2	1
		HS	2	2	3	2	3	1	1
IS	constraints	issue	COMA	AGRO	LAND	LOC	DEMO	ECON	Other
		EA	1	2	2	2	3	3	1
		HW	1	3	2	2	2	3	1
		IN	1	3	2	2	3	2	1
		HS	1	3	2	3	2	2	1
	opportunitie	issue	FATO	INMA	SF	SWC	IRR	LST	DOM
		EA	2	3	3	1	2	2	1
		HW	3	2	3	1	2	2	1
		IN	1	3	3	1	2	2	2
		HS	2	2	3	1	2	3	1
CDC	constraints	issue	NUTD	RADF	RAVA	LSHT	LASS		
		EA	3	1	2	1	3		
		HW	3	1	2	1	3		
		IN	3	1	2	1	3		
		HS	2	1	3	1	3		