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I. Template for the first round of semi-structured interviews¹

The study encompasses a vulnerability assessment of Navarre's farmers and how such vulnerability is influenced by modern irrigation. The information obtained from the interviews will be used confidentially. Personal information is only retained for potential follow-up procedures in the future, if necessary. The interview lasts approximately one and a half hours. I ask for your permission to record the interview. Thank you.

Interview number:	Sector:	Place:
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Introduction

Could you please tell me?

1. Your name and birth year (I also indicated gender):
2. Literacy level of number of years studied:
3. Your profession:
4. How do you connect your work to the agrarian sector?
5. How long have you been working in the agrarian sector?
6. How would you classify farmers in this area?
7. Could you tell me four types of agrarian practices common in the area?
8. How happy would you say you are regarding your livelihood? Why?

Vulnerability analysis and identification of key institutions

Stress factors

9. Please tell me about main problems within the rural sector (processes, changes, challenges) you have had to face in the last decade
10. Would you consider climatic stressors to be especially important, such as floods, droughts, rainfall volatility?
11. Please, specify the frequency, intensity, length and main effects on the land and farmers (such as crop lost)

¹ Though the interviews were conducted in Spanish, We are publishing the final questions as translated to English. If interested in reviewing the originals, they are available via the author.

12. Please tell me which are the two or three most important stressors from what we have discussed; why do you consider these the most important?

The following questions are linked to the two or three most important stressors mentioned:

Exposure and sensitivity

13. How often do stressors occur? (Length of the phenomena/magnitude/scope) (If relevant)
14. Do these problems affect all the crops equally? Which stressors are more impactful for cereals and vineyards?
15. From the previous classifications regarding farmer typologies within the zone, which type of farmer would you say is most exposed to the aforementioned challenges?
16. Would you say farmers with land in irrigated systems are less exposed? Which farmers are more sensitive? Why?
17. For the different types of farmers discussed, what were the outcomes of the stressors? Would you say those changes affected the existing relationships among the different farmers?
18. Do you know if affected farmers received any kind of help (financial, physical) to face the impacts of the stressors? If so, who gave this aid? What was this aid for, exactly?
19. Do you know if some of those climatic or environmental changes were beneficial for the communities? Why or why not? Can you provide an example?

Adaptive response

20. How did you react against those challenges? Could you avoid their effects? (selling, buying, emigrating) If so, how did you resist? (intensifying practices, diversifying crops, buying insurances, joining cooperatives, syndicates, asking for a credit)
21. Did you use rural knowledge to avoid being affected by stressors? Can you give me an example?
22. Have you started any additional activity (entrepreneurial) to absorb or ameliorate stressor's effect? Which one(s)?
23. Would you like to change any of your current activities to be less affected by the mentioned stressors?
24. Do you think that adopting modern irrigation could improve your situation? How? (More crop production and therefore higher economic gains, stronger social networks) Why? Could you tell me differences (accessing the market, legal rights and general advantages) between having either rainfed or irrigated systems?
25. Was adopting modern irrigation autonomous/assisted; automatic/planned; active/passive; a strategic reaction?
26. Did you foresee the problem (e.g. stressors)? How did you react once it had happened?
27. Do you think your reaction was effective? Efficient? Fair for you and for the rest of farmers?

28. Do you think your actions and modern irrigation have effects on the environment and for other people living in his area? Which effects and why? (Trade-offs)
29. Do you think some of the mentioned actions and modern irrigation could be mal-adaptation measures? Why? (Examples to prompt discussion: Do you think this may displace some farmers? Do you agree with your current cost of water? Do you think this transformation is displacing less costly, better options? Do you think modern irrigation creates more dependencies such as technological dependencies?)

Adaptive capacity

30. Which factors determine your actions? Are they determined by ecological features such as soil type? Personal knowledge and skills? Personal problem formulation? Social networks? Family? Personal financial situation (savings, debts, subsidies)?
31. From the aforementioned factors, which one do you think is the most important one? Can you mention other crucial assets to adapt?
32. On what does access to the mentioned assets and resources depend? (Access to the mentioned assets and resources), are there formal organisations establishing conditions to get access?
33. Which type of obstacles do you find when trying to adapt to the previously mentioned stressors, or when searching for your livelihoods sustainability? (Examples of obstacles: age, emigration/immigration, globalisation, market introduction, land attachment, others)
34. Do you consider modern irrigation to be an obstacle or an aid to be able to adapt to the mentioned stressors?

Institutions

35. Which organisations do you consider of key importance to solve rural sector problems? Would you highlight any practice, mechanism?
36. Who decides how to resolve problems within the rural sector? Are they individual/social decisions? Are there differences between those under irrigation and those under rainfed systems?
37. What are the main discussion themes? How are decisions made? Is there any assembly mechanism to make decisions? How often are those topics discussed? How those meetings are disseminated in order farmers notice and are able to participate in them?
38. Are there any organisations that you miss in the area? Why or why not?
39. Can you identify the main organisations and institutions that enhance modern irrigation? Which type of agriculture would you say is strengthened? (Intensification?)
40. How is water for irrigation managed? How can you be part of modern irrigation? What would you add, change or erase from modern irrigation operation?
41. Has this institution always existed? Is it substituting other one? Do you think it reaches its aims?

42. Are property rights different under irrigated or rainfed systems? How does modern irrigation influence property rights? (if relevant)
43. How do you think modern irrigation influences land labour and market access?
44. How can you get access to a bank credit? Is it easily accessible? What were the minimum requirements?
45. Is there financial aid connected to modern irrigation?
46. What rate of uncertainty exists in this sector change? Why might there be uncertainty?
47. Is modern irrigation and the subsequent access to irrigation water a discussion topic in the area? Between the existing livelihoods? Are there any conflicts linked to this topic? Why are there conflicts? Which parties are involved and what are their positions?
48. How do you think modern irrigation influences farmers' vulnerability to climatic and other types of stressors?

Extra questions if time permits

How is land redistributed, after the *concentración de tierras*?

How the definition of the irrigated zone was initially made?

Please tell me your opinion about the questions; what would you change and why?

Who else would you suggest to speak with?

II. Participants in the first round of interviews

The following Table describes the participants' profiles of the first-round interviews. Listed first are diverse farmers, followed by mixed stakeholders' profiles. Farmers were selected according to time invested in agriculture, type of crops, management approach, gender and age. 'Other' stakeholders were selected in relation to their involvement within the transformation to modern irrigation.

	Age	Gender	Area/zone	Profile	Land management system (If applicable)
I.1	Middle	Female	Southern Zone	Part-time; cereal ecologic system	Rainfed
I.2	Middle	Male	Medium area	Full-time; wine farm/vineyard	Irrigated and rainfed
I.3	Young	Male	Northern area	New farmer	Irrigated and rainfed
I.4	Middle	Male	Northern area	Full time	Irrigated and rainfed
I.5	Middle	Male	Northern area	Full time	Irrigated and rainfed
I.6	Old	Male	Northern area	Full time	Cooperative president
I.7	Middle	Male	Northern area	Part time	Irrigated system without installation
I.8	Middle	Male	Southern area	Full time	Irrigated
I.9	Old	Male	Southern area	Retired	Small plot
I.10	Middle	Female	Medium area	Part time	Rainfed
I.11	Middle	Female	Medium area	Part time	Traditional irrigated system
I.12	Middle	Male	Southern area	Full time	Conventional and ecological farming under irrigated and rainfed systems
I.13	Young	Female	n/a	n/a	Technician of AguaCanal
I.14	Middle	Male	n/a	n/a	Responsible of lands concentration of INTIA
I.15	Middle	Female	n/a	n/a	Responsible of agrarian farms training of INTIA
I.16	Middle	Male	n/a	n/a	Responsible of Projects and direction of canal work
I.17	Middle	Male	n/a	n/a	Head of agricultural production (I+D) of INTIA
I.18	Middle	Male	n/a	n/a	Technician of the negotiated of soils and climatology of Navarre Government
I.19	Middle	Male	n/a	n/a	Head of re-parceling negotiation of Rural development and environment department of Navarre Government
I.20	Middle	Female	n/a	n/a	Member of Nueva cultura del agua NGO

	Age	Gender	Area/zone	Profile	Land management system (If applicable)
I.21	Middle	Male	n/a	n/a	Manager of Artajona cooperative
I.22	Middle	Female	n/a	n/a	Technical head of the CPAEN Ecological Agriculture Council of Navarre
I.23	Middle	Male	Northern area	Part time	Worker of a city council, councilor of agriculture
I.24	Young	Female	n/a	n/a	Member of a consumption group
I.25	Young	Male	n/a	n/a	Member of a consumption group
I.26	Middle	Male	n/a	n/a	Technician of UAGN agrarian union in Navarre
I.27	Middle	Male	n/a	n/a	Technician of EHNE agrarian union in Navarre
I.28	Middle	Female	n/a	n/a	Member of a traditional irrigation community
I.29	Middle	Male	n/a	n/a	Agrarian economist professor at the University of Navarre

<35: Young; 35-55: Middle-aged; >55: Old

III. Template for the second round of semi-structured interviews

Introduction²

We are researching the governance and access to irrigation water. We analyse the evolution of the traditional irrigation to new irrigation from the Navarre Canal and the determinants of this transformation, as well as the effects of the Canal on irrigators and non-irrigators' livelihoods.

The information obtained from the interviews will be used confidentially. Your personal information is only retained for potential follow-up procedures in the future, if necessary. The data will be utilised to further understand the role that institutions have on the vulnerability of socio-ecological systems. The obtained information will be potentially published in a scientific journal which addresses these issues. The interview will last approximately one hour. I ask for your permission to record the interview Thank you.

Interview Questions

In the following questions I aim to understand how the system of irrigation in Miranda de Arga has changed over time; what are the causes of this evolution and the effects that it has on the farmers and/or affected owners' lives.

1. Please tell how the access to water has changed with the new modern irrigation system compared to the traditional one (20 min)
 - a. Are the same people obtaining access to water (resource and users boundaries)?
 - b. How many users (before and now); for how long time do they have the concession; which is the main use given; what are the conditions for access to modern irrigation water? Is there any relevant change you would mention?
 - c. How were/are the irrigation costs and benefits?
 - d. How are water-use decisions made (in both systems)? (Is there any assembly?)
 - e. How was/is the surveillance of the proper use of resources performed? Are there sanctions in case of infractions?
 - f. Who does the water originally belong to? Who manages it?
 - g. How were/are conflicts solved? (before and currently)
 - h. How were/are existing enterprises nested? (Irrigation community, AguaCANAL, INTIA, CHE etc.)
2. What socio-economic factors have addressed the change into modern irrigation?
 - a. Why have these changes been adopted, instead of an alternative?

² Though the interviews were conducted in Spanish, We are publishing the final questions as translated to English. If interested in reviewing the originals, they are available via the author.

- b. Which other processes/external institutions, have enhanced the shift from traditional irrigation to modernisation?
 - c. What are some advantages and disadvantages of the transformation to modern irrigation? (Who are the beneficiaries? Who are disadvantaged?)
 - d. Why is there conflict in the village? Could you explain contrasting narratives/viewpoints?
3. Which implications do those changes have on the farmers and owners' vulnerability?
- a. What are some of the effects/changes have on your life, on your land management practices, on your yield, to your family structure...
 - b. Which other factors (global) affect your livelihood sustainability
 - i. Crop selection and climate, price fluctuations, exposure
 - ii. Financial assets (insurances, subsidies, on property and rented land); knowledge (literacy and working experience)

Interview tools

Table 1 was used as an aid while stakeholders reported traditional and modern irrigation differences regarding the management of the organisations in charge and also concerning the rights and duties of the irrigation farmers.

Table 1 Notes used to aid interview conversation

TRADITIONAL IRRIGATION	MODERN IRRIGATION
<p>CREATION, AIM</p> <p>Origination</p> <p>Who defines it</p> <p>Who has rights to access</p> <p>How are norms and rules developed (statutes)</p> <p>What use(s) is/are given to water</p> <p>Conditions for the use of water</p> <p>Who ensures proper use of resources</p> <p>How are enterprises nested</p> <p>Water property (public, private, managed by...)</p> <p>How much water used, for what duration</p>	<p>CREATION, AIM</p> <p>Origination</p> <p>Who defines it</p> <p>Who has rights to access</p> <p>How are norms and rules developed (statutes)</p> <p>What use(s) is/are given to water</p> <p>Conditions for the use of water</p> <p>Who ensures proper use of resources</p> <p>How are enterprises nested</p> <p>Private property, managed by AguaCANAL</p> <p>How much water used, and for what duration</p>
<p>COMMUNITY LEADERS</p> <p>General board</p> <p>Government board</p> <p>Irrigation board</p> <p>Terms of office</p> <p>Voting</p>	<p>COMMUNITY LEADERS</p> <p>General board</p> <p>Government board</p> <p>Irrigation board</p> <p>Terms of office</p> <p>Voting</p>
<p>RIGHTS AND OBLIGATIONS OF PARTICIPANTS</p> <p>Right to water (how to access, how much, how are rights exercised)</p> <p>Voting conditions</p> <p>Construction, repair and maintenance, police and control costs</p>	<p>RIGHTS AND OBLIGATIONS OF PARTICIPANTS</p> <p>Right to water (how to access, how much, how are rights exercised)</p> <p>Voting conditions</p> <p>Construction, repair and maintenance, police and control costs</p>

Interview for policy-makers

Questions

With the following questions we are exploring the perception of the political process in the materialisation of the ‘Canal de Navarra’; both the modernisation of traditional irrigation as well as the transformation of the dryland into irrigated systems. Furthermore, I am investigating how different decisions have triggered the execution of the project and whose interests are taken into account.

1. Please, tell me how you see the decision-making process
 - a. Whose interests are promoted
 - i. Financial, social, cultural and/or ecological interests?
 - ii. Large-scale farmers’ or rather small-scale owners’?
 - iii. To progress (please define), modernity and efficiency claims?
 - b. How did the facts take place over time? Please, mention the most important milestones for you.
 - i. Norms and orders declarations
 1. At what scale (local, meso-level, macro-level (European and national))
 2. Are subsidies/incentives included?

3. Co-lateral effects of the interventions

- c. Justice vs. efficiency
 - i. Does the process sacrifice democratic governance at the expense of financial efficiency while maintaining the equality of the current power relations?
 - d. Certain groups ability to acquire benefits from resources (compared to other groups or livelihoods)
 - e. Restrictions and barriers identification to sustainable livelihoods opportunities
 - i. Delivered information (how was it executed)
 - ii. Time allotted for decision-making
 - iii. Recognition of livelihood diversity
 - iv. Decision-making participation (how, solely inform, voting)
 - v. Results of geographical conditions; technical elections and political agreements
 - vi. Appropriation, accumulation, transferability and resource distribution
 - vii. Particular actors' ability to influence others' ideas and practices
 - viii. Rights: ownership, heritage, use ...
 - ix. Individual vs. collective petitions
 - x. Conflict and cooperation over the benefits; previously constituted laws or resulting laws
 - xi. Influence over the access due to:
 - 1. Technology
 - 2. Market access
 - 3. Financial capital
 - 4. Knowledge
 - 5. Authority (legal systems that benefit some and harm others, how are they articulated)
 - 6. Social relations: friendship, trust, reciprocity, dependency and responsibility)
2. What is your opinion regarding the project aim and how it has actually been conducted?
3. What opinion do you think others have regarding the project? Regarding the process of the decision-making groups with opposing interests to yours (what do they think and why)

IV. Participants in the second round of interviews

The following Table describes the participants' profiles of the second-round interviews. Listed first are diverse farmers and owners of Miranda de Arga village, which correspond to the existing livelihoods. Next are multi-scale formal organisation representatives with diverse political stances towards the modern irrigation project. Farmers were selected according to the survey cluster results, which categorised participants consistent with their land management practices and diverse viewpoints.

	Age	Gender	Profile	Position towards modern irrigation
I.1	Young	Female	Large scale intensive farmer	In favour
I.2	Young	Male	Large scale intensive farmer	In favour
I.3	Experienced young	Male	Large scale intensive farmer	In favour
I.4	Experienced young	Male	Large scale intensive farmer	In favour
I.5	Middle	Male	Full time farmer	In favour
I.6	Middle	Male	Full time farmer	In favour
I.7	Old	Male	Retired farmer	In favour
I.8	Old	Male	Retired farmer	In favour
I.9	Middle	Female	Small scale diversified	Against and denied to sell
I.10	Middle	Male	Part time farmer	Against and displaced
I.11	Middle	Male	Part time farmer	Against and displaced
I.12	Old	Male	Retired farmer	Against and displaced
I.13	Old	Male	Part time farmer	In favour
I.14	Middle	Male	Part time farmer organic farmers	Against
I.15	Middle	Female	Former Miranda de Arga council major	?
I.16	Middle	Male	Worker of Miranda de Arga cooperative	In favour
I.17	Middle	Male	Personal in charge of the maintenance of the traditional irrigation system	In favour
I.18	Middle	Male	Member of Navarre parliament belonging to BILDU	Against
I.19	Middle	Male	Member of Navarre parliament belonging to UPN	In favour

<35: Young; 35-55: Middle-aged; >55: Old

V. Survey template

Introduction³

Hello, my name is Amaia Albizua and I am developing a PhD about agrarian ecosystem benefits. This PhD program is coursed at the [Institut de Ciència i Tecnologia Ambientals](#) (ICTA), Universitat Autònoma de Barcelona (UAB) and developed in the BC3 (Basque Centre for Climate Change), in Bilbao.

Questions about your livelihood (strategies, socio-demographic information etc.) and your opinion about modern irrigation project and related institutions will be made.

The information obtained from the survey will be used confidentially. Only myself will have access to the data and it will not be published online. Your personal information is only retained for potential follow-up procedures in the future, if necessary. The survey will last approximately one hour. I ask for your permission to record the conversation while filling the survey. Thank you.

³Though the interviews were conducted in Spanish, We are publishing the final questions as translated to English. If interested in reviewing the originals, they are available via the author.

Characterising questions: Socio-demographic, human, natural, physical, social and financial assets

General information

1	Gender	0=F; 1=M		Answers
2	Village	1= Añorbe 2= Obanos 3= Puente la Reina 4= Artajona 5= Larraga 6= Mendigorria 7= Tafalla	8= Falces 9= Miranda de Arga 10= Berbinzana 11= Olite 12= Caparroso 13= Marcilla 14= Peralta	15= San Martin de Unx 16= Beire 17= Ujué 18= Pitillas 19= Murillo el Cuende 20= Santacara 21= Murillo el Fruto
3	Age	N°		
4	Studies /Years of studies If university or professional studies, go to Q. 5	0= Non primary education 1= Basic and secondary education 3= Professional Training (2 years) 4= Professional Training (3 years or more) 5= University studies		
5	Are/were your studies related to agriculture?	0=No; 1=Yes		
6	Were you raised in a farmers' family? If yes, continue with Questions 7 and 8	0=No; 1=Yes		
7	From your agrarian knowledge, what percentage would you say is from your heritage or learnt at home?	%		
8	What percentage would you say is external (courses, books, magazines, Internet...)?	%		
9	How many years have you been working in this sector?	N°		
PROFILE				
10	1. Employee of agriculture (T) 2. Full-time farmer ATP (Aa) 3. Part-time farmer (Ab) 4. Agriculture manager (G) a. Owner b. Non-owner 5. Retired From agrarian sector From other sector			
11	Hours worked at highest peak (e.g. harvesting time) per day	N°		
12	Did you have to stop working last year due to health problems? (Please tell me approximately how many days)	0=None 1= 0-5 days due to minor issues (e.g. colds) 2= 10-20 days (minor) 3= More than a month (moderate) 4= More than two months (serious)		

13	Do you have any chronic illness(es) that may negatively affect your work?	0=No; 1=Yes	
14	Number of members in the household	N°	
15	Is agriculture the only source of income in the household?	0=No; 1=Yes	
16	How many household members work with you in agriculture?	N°	
17	How many household members are economically dependent on you?	N°	
18	Has any member of the household recently emigrated in search of work elsewhere? (to another city or country)?	0=No; 1=Yes	
19	Do you have generational replacement to continue your work?	0=No; 1=Yes	
20	Total land extension of the worked land	N° of Hectares:	
21	Are you owner of the land you work? If partially, continue to Questions 22-24 (profiles A and G)	0=No; 1=Yes; 2=Partially	
22	Percentage of worked land that you own	N°	
23	Percentage of worked land that you rent (indicate if communal land)	N°	
24	How many hectares do you work that are owned by others	N°	
25	Do you have CAP rights?	0=No; 1=Yes; 2=Partially (%); -9=Don't know	
26	Do you have land that is not worked by you personally? If yes, continue with Questions 27-32 (Profiles A and G)	N°	
27	Is someone else working that land?	0=No 1= Family or friends 2= Services enterprise 3= Cooperative	
28	Do you receive any rent?	0=No; 1=Yes	
29	Do you receive a proportional benefit regarding your land area transfer?	0=No; 1=Yes	
30	Do you decide which crops to grow?	0=No; 1=Yes	
31	Do you decide on the land management practices?	0=No; 1=Yes	
32	Do you invest in the infrastructure?	0=No; 1=Yes	
33	How many hectares do you own/rent in the modern irrigation transformed area? If >0, continue with Questions 35-39	N° of hectares:	
34	Before modern irrigation installation, did you have any other source of water access that permitted you to irrigate? Which one(s)?	0=No; 1=Yes (well, raft, traditional irrigation)	
35	Have you installed modern irrigation in your plots?	0=No; 1=Yes	
36	Which type of irrigation do you perform?	1=Sprinkling 2=Dropping 3=Others	
37	Do you share irrigation tanks with any neighbour? If yes, continue with Questions 38-39	0=No; 1=Yes	
38	With how many?	N° of neighbours	
39	Do you take turns to irrigate?	0=No; 1=Yes	

40	Do you rent agrarian machinery? (Profiles A and G)	0=No; 1=Tractor 2=Harvester 3=Small tools (e.g. hoe, etc.)	
41	Do you share machinery due to not owning all the necessary tools? (Profiles A and G)	0=No; 1= Tractor 2= Harvester 3= Small tools (e.g. hoe, etc.)	
42	What is your degree of participation within the cooperative?	0= Non-member 1= Very low 2= Low	3=Mediu m 4=High 5=Very high
43	What is your degree of participation degree within the syndicate? If affiliated with a syndicate, go to Question 44	0= Non-member 1= Very low 2= Low	3=Mediu m 4=High 5=Very high
44	To which syndicate do you belong?	1=UAGN 2=EHNE	3=UCAN 4=Other
45	Have you applied for any of the following subsidies? Which one(s)?	0=No; 1= FEADER (Rural development European agrarian funds) (CAP) 2= FEAGA (Guarantee European agrarian funds) (CAP) 3= Subsidies for agrarian farms modernisation (Navarre Government) 4= Subsidies for inversions on modern irrigation (Navarre Government) 5= Cooperative credit aids 6= CUMAS 7= Young farmers installation aids 8= Others (specify)	
46	Do you contract any agrarian insurance? Please specify.	0= No; 1= Climatic and other insurance (integral)	2= Hail insurance 3= Others (specify)
47	Do you sell your products directly (without intermediaries)?	0=No; 1=Yes (% of the total produced crops)	
48	Do you have any contracts with agro-industry?	0=No; 1=Yes	

IRRIGATION				RAINFED				
CROPS	Ha	Last year?	Which fertiliser do you use?		Ha	Last year?	Which fertiliser do you use?	
Winter cereals (winter-wheat / barley)	Ha	0=No; 1=Yes	1=Nitrates 2=Phosphates 3=Slurries	4=Sludge 5=Organic 6=Others	Ha	0=No; 1=Yes	1=Nitrates 2=Phosphates 3=Slurries	4=Sludge 5=Organic 6=Others
Vineyards	Ha	0=No; 1=Yes	1=Nitrates 2=Phosphates 3=Slurries	4=Sludge 5=Organic 6=Others	Ha	0=No; 1=Yes	1=Nitrates 2=Phosphates 3=Slurries	4=Sludge 5=Organic 6=Others
Corn	Ha	0=No; 1=Yes	1=Nitrates 2=Phosphates 3=Slurries	4=Sludge 5=Organic 6=Others	Ha	0=No; 1=Yes	1=Nitrates 2=Phosphates 3=Slurries	4=Sludge 5=Organic 6=Others
Other	Ha	0=No; 1=Yes	1=Nitrates 2=Phosphates 3=Slurries	4=Sludge 5=Organic 6=Others	Ha	0=No; 1=Yes	1=Nitrates 2=Phosphates 3=Slurries	4=Sludge 5=Organic 6=Others

49	Between irrigated and rainfed crops, which one demands a higher quantity of fertilisers?	1= More in irrigated systems; 3= Equal 2= More in rainfed systems	
50	Between irrigated and rainfed crops, which one demands higher amounts of pesticides?(quantity)	1= More in irrigated systems; 3= Equal 2= More in rainfed systems	

Changes and challenges

51	Has irrigation changed your life? If yes, continue to Questions 85-88 (+) / (-)	0=Not at all 1= Very low 2= Low 3= Medium 4= High 5=Very high		52	How does the change affect your land management practices?	0=Not at all 1= Very low 2= Low 3= Medium 4= High 5=Very high	
53	How does irrigation affect the crops production level?	0=Not at all 1= Very low 2= Low 3= Medium 4= High 5=Very high		54	How does irrigation affect your income?	0=Not at all 1= Very low 2= Low 3= Medium 4= High 5=Very high	
55	Do you work longer hours since the change to modern irrigation?	0=Not at all 1= Very low 2= Low 3= Medium 4= High 5=Very high		56	Is the absence of control over prices an important challenge for you? If yes, continue to Questions 90-91	0=Not at all 1= Very low 2= Low 3= Medium 4= High 5=Very high	
57	How much does the absence of control over prices affect your income?	0=Not at all 1= Very low 2= Low 3= Medium 4= High 5=Very high		58	How much does the absence of control over prices affect your happiness levels?	0=Not at all 1= Very low 2= Low 3= Medium 4= High 5=Very high	
59	Is drought an important challenge you have to face? If yes, continue to Questions 93-96	0=Not at all 1= Very low 2= Low 3= Medium 4= High 5=Very high		60	How much does drought affect your land management practices?	0=Not at all 1= Very low 2= Low 3= Medium 4= High 5=Very high	
61	How much does drought affect the production level?	0=Not at all 1= Very low 2= Low 3= Medium 4= High 5=Very high		62	How much does drought affect to your income?	0=Not at all 1= Very low 2= Low 3= Medium 4= High 5=Very high	
63	How much does it affect your happiness?	0=Not at all 1= Very low 2= Low 3= Medium 4= High 5=Very high		64	Which years, among the last ten years, were the hardest in this regard?		
65	Is the absence of official support an important challenge you have to face? If yes, continue to Questions 99-100	0=Not at all 1= Very low 2= Low 3= Medium 4= High 5=Very high		66	How much does it affect to your income?	0=Not at all 1= Very low 2= Low 3= Medium 4= High 5=Very high	
67	How much does it affect your happiness?	0=Not at all 1= Very low 2= Low 3= Medium					

		4= High 5=Very high				
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Adaptation strategies after modern irrigation transformation

68	Did you change your lands to a rainfed area after the transformation?	0=No; 1=Yes; (N° Hectares)	
69	Have you decided to leave the agrarian sector and begin a new profession?	0=No; 1=Yes	
70	Have you sold all or a portion of your lands?	0=No; 1=Yes (N° Hectares)	
71	Have you rented all or a portion of your lands? If yes, continue to Question 105	0=No; 1=Yes (N° Hectares)	
72	Who do you rent your lands to?	1= Family / Friends 2= Cooperative 3= Others	
73	Have you partially left the agrarian sector? If yes, continue to Questions 107-108	0=No; 1=Yes	
74	Please indicate the percentage of time dedicated to land labour	0 = None 1 = Very low 2= Low	3= Medium 4= High 5= Very high
75	Please indicate the percentage of rent obtained from agrarian land	0 = None 1 = Very low 2= Low	3= Medium 4= High 5= Very high
76	Have you bought new land under modern irrigation system?	0=No; 1=Yes (N° Hectares)	
77	Have you rented new land under modern irrigation system?	0=No; 1=Yes (N° Hectares)	
78	How much do you use INTIA advice aid?	0 = Not at all 1 = Very low 2= Low	3= Medium 4= High 5= Very high
79	Have you diversified your crops after modern irrigation transformation? If yes, continue to Question 113	0=No; 1=Yes	
80	How many additional crops do you have currently compared to previous years?	N° of crops	
81	Have you completed any training course to use modern irrigation?	0=No; 1=Yes	
82	Have you joined with any other organisation that provides aid for the modern irrigation use?	0=No; 1=Yes	
83	Have you joined with other farmers to create a CUMA?	0=No; 1=Yes	
84	Have you asked for credit from any bank?	0=No; 1=Yes	
85	Once the transformation is made, how much money can you save financially?	0= None 1= Very low 2= Low	3=Medium 4=High 5=Very high
86	Have you changed land management practices in search of increased soil quality?	0=No; 1=Yes	
87	Do you have any other project in mind to improve your livelihood in a near future?	0=No; 1=Yes (If yes, please specify) -9=Don't know	

Cognitive capacities

88	<i>Please rate your satisfaction levels with agrarian activity.</i>	0= None 1= Very low 2= Low	3=Medium 4=High 5=Very high	
89	<i>Do you trust joining other farmers to perform agrarian activity?</i>	0= Not at all 1= Very low 2= Low	3=Medium 4=High 5=Very high	
90	<i>Please rate the level of difficulty in learning how to use the new technology.</i>	0= None 1= Very low 2= Low	3=Medium 4=High 5=Very high	
91	<i>Is age a factor when considering the adoption of new land management options, i.e. modern irrigation?</i>	0= Not at all 1= Very low 2= Low	3=Medium 4=High 5=Very high	
82	<i>Please rate your level of conservatism regarding land management practices?</i>	0= None 1= Very low 2= Low	3=Medium 4=High 5=Very high	
93	<i>Please rate the importance in which you attribute to your freedom; i.e. the power of decision-making and ability to work for yourself.</i>	0= None 1= Very low 2= Low	3=Medium 4=High 5=Very high	
94	<i>Please indicate your level of attachment towards your land</i> <i>If answered Medium, High, or Very High, please continue to Question 128</i>	0= No 1= Very low 2= Low	3=Medium 4=High 5=Very high	
95	<i>Does your (high) level of attachment towards your land influence your decision to sell it?</i>	0=No; 1=Yes; -9 Don't know		
96	<i>What level would you rate on science?</i>	0= None 1= Very low 2= Low	3=Medium 4=High 5=Very high	
97	<i>Do you think administrative bureaucracy is an obstacle in maintaining your livelihood?</i>	0= No 1= Very low 2= Low	3=Medium 4=High 5=Very high	
98	<i>Do you share information regarding the climate, favourable land management practices, etc. with your neighbours?</i>	0= No 1= Very low 2= Low	3=Medium 4=High 5=Very high	
99	<i>Do you have Internet access?</i>	0=No; 1=Yes		
100	<i>Do you use the Internet to obtain information about agrarian related topics? (Seed prices, Climate forecasts, subsidies, etc.)</i>	0=No; 1=Yes		
101	<i>If necessary, would you trust getting financial aid from your family or friends?</i>	0=No; 1=Yes		

Local perception about modern irrigation transformation process

102	Do you think that the 'Canal de Navarra' modern irrigation transformation is necessary?	0= No 1= Very low 2= Low	3=Medium 4=High 5=Very high	
103	Do you think the transformation is being developed in an adequate way? (write down comments)	0= No 1= Very low 2= Low	3=Medium 4=High 5=Very high	
104	Do you agree with the Phase One extension in the traditional irrigation lands?	0= No 1= Very low 2= Low	3=Medium 4=High 5=Very high	
105	Do you think adopting modern irrigation is necessary to avoid becoming obsolete in the sector?	0= No 1= Very low 2= Low	3=Medium 4=High 5=Very high	
106	Do you think your election to use modern irrigation was influenced by outside agencies?	0= No 1= Very low 2= Low	3=Medium 4=High 5=Very high	
107	Do you feel this decision makes you less vulnerable to climatic factors?	0= No 1= Very low 2= Low	3=Medium 4=High 5=Very high	
108	Do you think a consequence of modern irrigation transformation is that there are now less farmers for the same land-area? (write down reasons if commented)	0= No 1= Very low 2= Low	3=Medium 4=High 5=Very high	
109	Do you think this kind of transformation only benefits the 'professional' farmer?	0=No; 1=Yes; 2=to all but this one specially; -9 Don't know		
110	Are you satisfied with the <i>concentración de tierras</i> process?	0=No; 1= Yes; -9 Don't know		
111	Do you know what your options are if you do not agree with the <i>concentración de tierras</i> process?	0=No; 1= Yes; -9 Don't know; 2= Yes, but it might not make a difference		
112	Do you think there are favouritisms in the <i>concentración de tierras</i> and re-distribution processes?	0=No; 1= Yes; -9 Don't know		
113	Have you missed out on procedural information regarding the process?	0= No 1= Very low 2= Low	3=Medium 4=High 5=Very high	
114	Do you feel as if you were given an appropriate amount of time to decide if you wanted to be included within the modern irrigation transformation?	0= No 1= Very low 2= Low	3=Medium 4=High 5=Very high	
115	From your perspective, how has agriculture changed with the introduction of modern irrigation?	Please specify.		
116	Do you agree with the modern irrigation taxes? (Specify.)	0= No 1= Very low 2= Low	3=Medium 4=High 5=Very high	

117	Do you think modern irrigation will make you more competitive in the market?	0=No; 1= Yes; -9 Don't know	
118	Have you had any trouble with the plots' ownership deeds when the <i>concentración de tierras</i> was made?	0=No; 1= Yes; -9 Don't know	
119	Please indicate how	1=I was the owner but I have no certificate to demonstrate it (I have lost rights) 2= I paid the council to obtain my rights 3= Other	
120	Do you think it would be better if water came from another source other than the Navarre Canal? (Specify.)	0=No; 1= Yes; -9 Don't know; 2= There was no other option	
121	How long do you anticipate until you are able to see the benefits of the irrigation transformation?	0=Never 1=Short-term (1-5 years) 2=Medium-term (5-8 years) 3=Long-term (8-15 years) 4=Very long-term (>15 years)	
122	Do you think modern irrigation affects positively soil/environmental conditions? (Specify)	0=No; 1= Yes; -9 Don't know	
123	Do you think modern irrigation influences negatively soil environmental conditions?? (Specify)	0=No; 1= Yes; -9 Don't know	
124	How do you think modern irrigation differently influences farmers and owners within that area? (Social effects)		
125	Do you think communal land is affected in a different way? (Please specify)	0=No; 1= Yes; -9 Don't know	
126	Please mention the three weakest and two strongest features of modern irrigation (Please specify)	+	-

Do you know anyone who has left the sector following the transformation to modern irrigation? (If so, please indicate how many people you have known in this situation, and provide names if possible)

Institutions

127	Do you view CAP positively (due to its subsidies)?	0= No 1= Very low 2= Low	3=Medium 4=High 5=Very high	
128	Do you view CAP negatively (due to its subsidies)?	0= No 1= Very low 2= Low	3=Medium 4=High 5=Very high	
129	Do you think the state government is of key importance to aid the rural sector?	0= No 1= Very low 2= Low	3=Medium 4=High 5=Very high	
130	Do you think the Navarre government is of key importance to aid the rural sector?	0= No 1= Very low 2= Low	3=Medium 4=High 5=Very high	
131	Do you think the existence of the organic agriculture board is important to commercialise these types of products?	0= No 1= Very low 2= Low	3=Medium 4=High 5=Very high	
132	Please indicate the level of involvement you perceive the agrarian syndicates have for the defence of farmers' interests?	0= None 1= Very low 2= Low	3=Medium 4=High 5=Very high	
133	Please indicate the level of trust you have for agrarian syndicates	0= None 1= Very low 2= Low	3=Medium 4=High 5=Very high	
134	To what extent do you think URA-Nueva Cultura del Agua is of key importance for farmers' interests' defence?	0= None 1= Very low 2= Low	3=Medium 4=High 5=Very high	
135	To what extent do you think INTIA helps promote the sustainability of the Navarre agrarian sector?	0= Non-member 1= Very low 2= Low	3=Medium 4=High 5=Very high	
136	To what extent do you think the role of the irrigation community plays in negotiating irrigation conditions?	0= Non-member 1= Very low 2= Low	3=Medium 4=High 5=Very high	
137	To what extent do you think the agrarian cooperative is a key representative organisation for the farmers?	0= Non-member 1= Very low 2= Low	3=Medium 4=High 5=Very high	
138	To what extent do you think CHE helps the agrarian sector?	0= Non-member 1= Very low 2= Low	3=Medium 4=High 5=Very high	
139	To what extent are you satisfied with the council you belong to?	0= Non-member 1= Very low 2= Low	3=Medium 4=High 5=Very high	
140	Do you think the village farmers are united?	0= Non-member 1= Very low 2= Low	3=Medium 4=High 5=Very high	
141	Do you think there is union between farmers from different villages?	0= Non-member 1= Very low 2= Low	3=Medium 4=High 5=Very high	

142	Please, mention the three laws, norms, organisations you consider most important for helping farmers. And the three worst? (Please specify why)	+	-
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VII. Vulnerability analysis

Table 2 shows in its first column the different stress factors and the shock farmers in *Itoiz-Canal de Navarra* region face. Second column refers to the measure unit. Third column provides a definition of each stress factor and shock followed by a further definition in the fourth column; the potential outcome for each livelihood in the sixth column and the references used are showed in the last column.

Table 2. Exposure to climate variability and market prices volatility

Type of stress	Unit of meas.	Variable definition	Definition	Potential outcome for livelihood	Reference
Climate variability	Celsius	Mean standard deviation of the daily average maximum T by month between 1925-2009	What changes imply for the distribution of inter-annual agricultural productivity changes in the distributions of temperature	Food/income insecurity	(Hahn et al. 2009; Ahmed et al. 2010)
	Celsius	Mean standard deviation of the daily average minimum T by month between 1925-2009	What changes imply for the distribution of inter-annual agricultural productivity changes in the distributions of temperature	Food/income insecurity	(Hahn et al., 2009; Ahmed et al., 2010)
	Mm	Mean standard deviation of the daily average precipitation by month between 1925-2009	What changes imply for the distribution of inter-annual agricultural productivity changes in the distributions of precipitation	Food/income insecurity	(Hahn et al., 2009; Ahmed et al., 2010)
Drought	Mm	Average number of drought in the last 10 years: Mean precipitation-ETP Potential of Thorntwaite	What changes imply for the distribution of inter-annual agricultural productivity changes in the distributions of hydric stress	Food/income insecurity Conflict over natural resources	(Hahn et al. 2009; Ahmed et al. 2010; Maru et al. 2014)
Prices volatility ⁴	Eur	Mean standard deviation of the prices perceived by farmers for each crop	What changes imply for the distribution of inter-annual agricultural income changes in the distributions of prices	Income insecurity	(O'Brien et al. 2004; Haile et al. 2013)

⁴ Price volatility is the third analysed stressor. For each crop, Before doing this, it was important to subtract the inflation effect of the years prior to 2013, which was done using the annual average consumption prices index (Instituto Nacional de Estadística, 2015). Mean price divided by the standard deviation gives a ratio that can be compared with the mean annual inflation to interpret whether those fluctuations have a strong effect on the household economy. The standard deviation of crop prices was used to calculate exposure to prices volatility

Type of stress	Unit of meas.	Variable definition	Definition	Potential outcome for livelihood	Reference
		(1995-2013) (sum of the STDEV of all the crops per farmer)			

Table 3 presents the variables, definition and how such variables mediate the intensity of climate related stressors as well as the references where these ideas can be found.

Table 3. Sensitivity and adaptive capacity to climate variability related stressors

Variable definition	Unit of meas.	Definition	How the intensity of the stressor is mediated	Reference
Household members economically dependent (+)*	Ratio	Number of incapable people who depend on the household	The effect of the climate hazard and consequent crop lost would be higher if more people is affected	(Hahn et al. 2009; Notenbaert et al. 2013; Ifejika Speranza et al. 2014)
Ha of grown crop sensitive to lack of precipitation (+)**	Ha	Area of the most sensitive crop known in the area	The percentage of land that can be irrigated will suffer less from climate variability	(Ifejika Speranza et al. 2014)
Crop diversity (-)	Number of crops	Number of different crops each farmers has	Number of different crops planted by a household make the household less sensitive since such crop will have different responses to hazards being variable their resistance to hazards	Hahn et al (2009) Eakin and Bojorquez-Tapia (2008)

* Confusion about who is an elder dependent and how many children are dependent when both parents worked

** Type of crops already account for this differences since they have different hydric necessities

Adaptive capacity					
	Variable	Unit of measurement	Definition	How the intensity of the stressor is mediated	Reference
Human	Education: Level of literacy (+)	0= No studies 1= Primary education 3= Secondary intermediate 4= Secondary up 5= University	An individual equipped with knowledge to respond to stressors and shocks	The level of education provides tools to react to climate hazards.	(Eakin and Bojórquez-Tapia 2008; Hahn et al. 2009; Ifejika Speranza et al. 2014) (Notenbaert et al. 2013)
	Education: Agrarian studies (+)	No=0, Yes=1	An individual with a high level of knowledge about agricultural practices	This agrarian knowledge will better equip individuals against stressors and shocks	(Eakin and Bojórquez-Tapia 2008; Ifejika Speranza et al. 2014) (Notenbaert et al. 2013)
	Education: farming experience (+)	Ln(Years)	Knowledge which provides a holistic perspective in response to stressors on farming	Experience in farming provides farmers with knowledge to react	(Ifejika Speranza et al. 2014)
Socio-demographic	Human workforce (+)	Number of relatives working in the farm	Human labour	The higher the number, the higher the response	(Ifejika Speranza et al. 2014)(Notenbaert et al. 2013)
	Female headed household (-)	0=F; 1=M	Recognition of the negative role that gender plays on socio-political relations within the sector; females are more severely impacted by this inequality	In a female-lead household, she may encounter more obstacles in accessing information, thus able to react to stressors and shocks	(Hahn et al. 2009) (Notenbaert et al. 2013)
	Age (-)	Ln(Years)	Age of the participant	The older an individual, the less likely it is to develop adaptation strategies	(Eakin and Bojórquez-Tapia 2008) (Notenbaert et al. 2013)
Financial	Agrarian land ownership (+)	Percentage	Percentage of land under legal right of possession	Ownership does not necessarily facilitate freedom of decision, the percentage of owned land is also important for certain decisions	(Eakin and Bojórquez-Tapia 2008)

Adaptive capacity					
	Variable	Unit of measurement	Definition	How the intensity of the stressor is mediated	Reference
	Rented agrarian land (-)	Percentage	Percentage of rented land	Renting land decreases decision capabilities	(Eakin and Bojórquez-Tapia 2008)
	CAP Subsidy access (+)	No=0, Yes=1	Communitarian Agrarian Policy subsidies	In the event of a climate hazard resulting in crop loss, extra income allows for replacement purchases appropriate for their livelihood practices	(Eakin and Bojórquez-Tapia 2008)
	Irrigation subsidy access (+)	No=0, Yes=1	Economic aid to promote irrigation	Economic aid to ensure farms' resistance to hazards	(Eakin and Bojórquez-Tapia 2008)
	Modernisation subsidy access (+)	No=0, Yes=1	Economic aid to promote modernisation	Economic aid to ensure farms' resistance to hazards	(Eakin and Bojórquez-Tapia 2008)
	Integral agrarian insurance access (+)	No=0, Yes=1	Contracted coverage which protects the insured from financial loss from any meteorological hazard	Compensation in the event of a climate hazard	(Eakin and Bojórquez-Tapia 2008)
	Hail agrarian insurance (+)	No=0, Yes=1	Contracted coverage which protects the insured from financial loss from hail damage	Compensation in the event of hail	(Eakin and Bojórquez-Tapia 2008)
	Others agrarian insurance (+)	No=0, Yes=1	Contracted coverage which protects the insured from financial loss covering other risks affecting agricultural production	Compensation for other hazards	(Eakin and Bojórquez-Tapia 2008)
Physical	Percentage of the area of crops irrigated	No=0, Yes=1	Modern infrastructure for irrigation	Competitive in terms of efficiency land management	(Eakin and Bojórquez-Tapia 2008)
Social networks	Grade participation as cooperative member	0='No', 1='Low', 3='Medium', 4='High	Cooperatives offer assistance with accessing subsidies, cheaper feed and energy, crop commercialisation, management guidance, etc.	Integration within the cooperative provides information and decision-making competence	(Eakin and Bojórquez-Tapia 2008; Ifejika Speranza et al. 2014) (Notenbaert et al. 2013)
	Grade participation as syndicate member	0='No', 1='Low', 3='Medium', 4='High	Syndicates defend farmers and help with access to subsidies, etc.	Integration within the syndicate provides information and decision-	(Eakin and Bojórquez-Tapia 2008; Ifejika Speranza et al. 2014)

Adaptive capacity					
	Variable	Unit of measurement	Definition	How the intensity of the stressor is mediated	Reference
				making competence. This membership/participation in social networks can increase other assets (insurance, subsidies)	(Notenbaert et al. 2013)
	Grade of information shared with friends or neighbours	0='No',1='Low',3='Medium',4='High	Recognition that an open communication with neighbours and friends facilitates response capacity and increases social cohesion	The more information shared, the higher adaptive capacity. Information and adaptive capacity are directly correlated	Speranza et al., 2014

Table 4 presents the variables, definition and how such variables mediate the intensity of crop prices volatility effects over farmers' vulnerability as well as the references where these ideas can be found.

Table 4. Sensitivity to crop prices volatility related stressors

Variable	Unit of meas.	Definition	How the intensity of the stressor is mediated	Reference
Income diversification *	Yes / No	Agriculture accounts for 100% of the expenses entering in the household	Those with a varied source of income are more financially protected against agricultural price volatility	Hahn et al (2009)
Household members economically dependent (+)	Ratio	Number of individuals who are dependent on the household	The higher the amount of people are impacted by potential stressors and shocks, the more sensitive the household will be.	(Hahn et al. 2009; Notenbaert et al. 2013; Ifejika Speranza et al. 2014)
Crops diversification	Number of crops	Number of different crops hold by a household	The more diverse the crops, the less sensitive the farmers will be if one crop is negatively affected (price rate, climate stressors)	Hahn et al (2009) Eakin and Bojorquez-Tapia (2008)
Percentage of the crops directly sold	Percentage	Percentage of the crops directly sold	When crops are directly commercialised (at local level), there is more stability, as international market fluctuations will only have indirect effects	(Isakson 2014)
Contract with agro-industry **	Yes / No	Contract with agro-industry	Comparative advantage to other farmers; having the contracts and rights to grow and market particular vegetables	

*Percentage of income unknown

**We did not account for the area under contract

Adaptive capacity					
	Variable	Unit of measurement	Definition	How the intensity of the stressor is mediated	Reference
Human	Education: Level of literacy	0= No studies 1= Primary education 3= Secondary intermediate 4= Secondary up 5= University	An individual with the knowledge to anticipate price volatility and crop suitability	Education level provides tools to better react against price volatility	(Eakin and Bojórquez-Tapia 2008; Ifejika Speranza et al. 2014) (Notenbaert et al. 2013)
	Education: farming experience	Ln(Years)	Set of knowledge that provides a holistic perspective in response to farming stressors	Farming experience provides knowledge to react	(Ifejika Speranza et al. 2014)
Socio-demographic	Female headed household	0=F; 1=M	Recognition of the negative role that gender plays on socio-political relations within the sector; females are more severely impacted by this inequality	In a female-lead household, she may encounter more obstacles in accessing information, thus able to react to stressors and shocks	(Hahn et al. 2009) (Notenbaert et al. 2013)
	Age (-)	Ln(Years)	Age of the participant	The older you are, less likely it is that you will be able to develop adaptation strategies	(Eakin and Bojórquez-Tapia 2008) (Notenbaert et al. 2013)
Financial	Owned agrarian land	Percentage	Percentage of land under legal right of possession	Being owner facilitates freedom for decision	(Eakin and Bojórquez-Tapia 2008)
	Rented agrarian land (-)	Percentage	Percentage of rented land	Renting land decrease freedom for decision	(Eakin and Bojórquez-Tapia 2008)
	CAP Subsidy access	Yes / No	Communitarian Agrarian Policy subsidies	If there is a climate hazard and they lose their crops their have an extra income entrance to buy new seeds or whatever strategy they follow	(Eakin and Bojórquez-Tapia 2008)

Adaptive capacity					
	Variable	Unit of measurement	Definition	How the intensity of the stressor is mediated	Reference
	Irrigation subsidy	Yes / No	Economic aid directed to irrigation promotion	They have economic aid to make their farm more resistant to hazards	(Eakin and Bojórquez-Tapia 2008)
	Modernisation subsidy	Yes / No	Economic aid directed to modernisation promotion	They have economic aid to make their farm more resistant to hazards	(Eakin and Bojórquez-Tapia 2008)
Social networks	Grade participation as cooperative member	0= None; 1= Very low; 2= Low; 3=Medium; 4=High; 5=Very high	Cooperatives help on accessing subsidies, cheaper feed and energy, commercialize crops, management guiding etc.	The more integrated in the cooperative the more power to decide and be informed	(Eakin and Bojórquez-Tapia 2008; Ifejika Speranza et al. 2014) (Notenbaert et al. 2013)
	Grade participation as syndicate member	0= None; 1= Very low; 2= Low; 3=Medium; 4=High; 5=Very high	Syndicates defend farmers and help on access to subsidies etc.	The more integrated in the cooperative the more power to decide and be informed	(Eakin and Bojórquez-Tapia 2008; Ifejika Speranza et al. 2014) (Notenbaert et al. 2013)
	Grade of information shared with friends or neighbours	0= None; 1= Very low; 2= Low; 3=Medium; 4=High; 5=Very high	Recognition that an open communication with neighbours and friends facilitates response capacity and increase social cohesion	The more information shared, the higher adaptive capacity	Speranza et al., 2014

sub-components, components and overall VI to climate variability and drought.

Components and overall VI to climate variability and drought

	Small-scale diversified farmers (SDi)		Medium-scale rainfed organic farmers (MRO)		Medium-scale intensive farmers (MI)		Large-scale intensive farmers (LI)		All livelihoods	All livelihoods
	mean	Major comp.	mean	Major comp.	mean	Major comp.	mean	Major comp.	Max.	Min.
Economic dependent	0.77		1.64		1.57		1.06		8.00	0.00
Inverse of number of farmers)	0.44	0.13	0.41	0.16	0.42	0.17	0.36	0.12	1.00	0.20
Crop maize (hectares)	0.52		10.68		33.16		27.81		1100	0.00
Age (0=no; 1=yes)	0.97		1.00		1.00		0.98		1.00	0.00
Age (0=0-5 years), (2= 5-10 years), (3= 10-20 years), (4= 20-30 years), (5= 30-40 years), (6= 40-50 years), (7= 50-60 years), (8= >60 years)	0.10	0.56	0.18	0.59	0.22	0.62	0.18	0.61	1.00	0.00
Age (0=0-55 years), (1= 55-65 years), (2= 65-75 years), (3= >75 years)	3.43		3.33		3.52		3.71		5.00	1.00
Age (0=0-55 years), (1= 55-65 years), (2= 65-75 years), (3= >75 years)	4.08		3.94		3.91		4.02		4.51	3.09
Number of members working in the household	0.39	0.58	0.14	0.54	0.40	0.55	0.36	0.57	4.00	0.00
Gender (0=female, 1=male)	0.90		1.00		0.99		0.96		1.00	0.00
Education (0=no; 1=yes)	0.70		0.91		0.93		0.94		1.00	0.00
Government subsidy (0=no; 1=yes)	0.11		0.52		0.40		0.38		1.00	0.00
Government subsidy (0=no; 1=yes)	0.19		0.71		0.68		0.60		1.00	0.00

	Small-scale diversified farmers (SDi)		Medium-scale rainfed organic farmers (MRO)		Medium-scale intensive farmers (MI)		Large-scale intensive farmers (LI)		All livelihoods	All livelihoods
	mean	Major comp.	mean	Major comp.	mean	Major comp.	mean	Major comp.	Max.	Min.
subsidy (0=no;	0.00		0.05		0.11		0.06		1.00	0.00
insurance (0=no;	0.17	0.18	0.41	0.36	0.53	0.38	0.43	0.34	1.00	0.00
access (0=no; 1=yes)	0.28		0.41		0.60		0.52		1.00	0.00
irrigation (0=no;	0.05		0.14		0.19		0.13		1.00	0.00
own land (0=no;	0.68		0.84		0.41		0.97		66.67	0.00
rented land (0=no; 1=yes)	0.18		1.85		0.46		0.44		30.00	0.00
own =yes)	0.39	0.40	0.62	0.70	0.76	0.80	0.56	0.64	1.00	0.00
stallation (0=no;	0.40		0.77		0.84		0.73		1.00	0.00
with neighbours	0.88		1.00		0.97		0.91		1.00	0.00
relationship (0=no; 1=yes)	0.79	0.66	0.86	0.83	0.93	0.90	0.90	0.83	1.00	0.00
trip (0=no; 1=yes)	0.32		0.64		0.79		0.68		1.00	0.00
temperature of the daily temp by month (°C)	6.88		6.74		6.68		7.20		7.80	5.02
temperature of the daily temp by month (°C)	5.01	0.65	4.92	0.62	4.82	0.61	5.08	0.56	5.38	3.32
precipitation of the daily by month (mm)	131.0		131.1		131.6		119.8		147.20	108.10
	-223.0		-223.3		-219.8		-268.5		-126.3	-325.6
	0.53		0.43		0.40		0.42			

Table 6 presents results regarding the sub-components, components and overall VI to price volatility.

Table 6. Sub-components, major components, and overall vulnerability index to price volatility

Major comp.	Sub-components	Small-scale diversified		Organic		Intensive		Large-scale intensive		All livelihoods	All livelihoods
		mean	Major comp.	mean	Major comp.	mean	Major comp.	mean	Major comp.	Max.	Min.
Livelihood strategies	Unique income	0.33		0.36		0.48		0.46		2.00	0.00
	Family member economic dependent	0.77		1.64		1.57		1.06		8.00	0.00
	Crops diversity	0.44	0.44	0.41	0.46	0.42	0.48	0.36	0.43	1.00	0.20
	Direct Sell	0.78		0.77		0.89		0.82		1.00	0.01
	Agro industry Work	0.97		0.95		0.90		0.90		1.00	0.50
Human	Studies	0.97	0.79	1.00	0.80	1.00	0.81	0.98	0.83	1.00	0.00
	Work experience	3.43		3.33		3.52		3.71		1.00	0.00
Socio-demographic	Age ⁷	4.08	0.80	3.94	0.80	3.91	0.78	4.02		4.51	3.09
	Gender	0.90		1.00		0.99		0.96	0.81	1.00	0.00
Financial	PAC	0.70		0.91		0.93		0.94		1.00	0.00
	Modernisation subsidy	0.11		0.52		0.40		0.38		1.00	0.00
	Irrigation subsidy	0.19	0.18	0.71	0.38	0.68	0.35	0.60	0.33	1.00	0.00
	CUMA subsidy	0.00		0.05		0.11		0.06		1.00	0.00
	Percentage of owned land	0.68		0.84		0.41		0.97		66.67	0.00
	Percentage of rented land	0.18		1.85		0.46		0.44		30.00	0.00
Physical	Internet Use	0.39	0.39	0.62	0.62	0.76	0.76	0.56	0.56	1.00	0.00
Social	Information shared with neighbours	0.88		1.00		0.97		0.91		1.00	0.00
	Cooperative membership	0.79	0.66	0.86	0.83	0.93	0.90	0.90	0.83	1.00	0.00
	Syndicate membership	0.32		0.64		0.79		0.68		1.00	0.00
Price volatility	Exposure to price volatility	39.27	0.01	133.45	0.02	402.13	0.07	279.59	0.05	5721.71	0.00

⁷ Log age.

		Small-scale diversified		Organic		Intensive		Large-scale intensive		All livelihoods	All livelihoods
Major comp.	Sub-components	mean	Major comp.	mean	Major comp.	mean	Major comp.	mean	Major comp.	Max.	Min.
VI prices		0.46		0.36		0.36		0.38			

Table 7 and Table 8 present results regarding the sub-components, components and overall VI to climate variability and drought and crop prices volatility respectively after a standardisation process. I calculated the inverse of these variables when calculating the 7-component based VI since they counteract vulnerability. The original values, however, were used for the VI index calculation when aggregated in three components, since adaptive capacity is already included in the formula as a subtraction.

Table 7. Indexed sub-components, major components, and overall vulnerability index to climate variability and drought

Vulnerability climate variability								
Sub-component	SDi	Major Comp	MRO	Major Comp	MI	Major Comp	LMI	Major Comp
Family members economic dependent	0.10		0.20		0.20		0.13	
Crops diversification (inverse)	0.30	0.13	0.27	0.16	0.28	0.17	0.21	0.12
Ha of irrigated maize	0.00		0.01		0.03		0.03	
Studies	0.97		1.00		1.00		0.98	
Agrarian studies	0.10	0.56	0.18	0.59	0.22	0.62	0.18	0.61
Working experience	0.61		0.58		0.63		0.68	
Age (log)	0.70		0.60		0.57		0.65	
Family members working in the sector	0.10	0.58	0.03	0.54	0.10	0.55	0.09	0.57
Gender	0.90		1.00		0.99		0.96	
PAC subsidy	0.70		0.91		0.94		0.93	
Modernisation subsidy	0.11		0.52		0.38		0.40	
Irrigation subsidy	0.19		0.71		0.68		0.60	
CUMA subsidy	0.00		0.05		0.11		0.06	
Integral Insurance	0.17	0.18	0.41	0.36	0.53	0.38	0.43	0.34
Hail Insurance	0.28		0.41		0.60		0.52	
Other Insurance	0.05		0.14		0.19		0.13	
Percentage of owned land	0.01		0.01		0.01		0.01	
Percentage of rented land	0.01		0.06		0.02		0.01	
Internet use	0.39	0.40	0.62	0.70	0.76	0.80	0.56	0.64

Vulnerability climate variability								
Sub-component	SDi	Major Comp	MRO	Major Comp	MI	Major Comp	LMI	Major Comp
Modern irrigation installation	0.40		0.77		0.84		0.73	
Info shared with neighbours	0.88		1.00		0.97		0.91	
Cooperative member	0.79	0.66	0.86	0.83	0.93	0.90	0.90	0.83
Syndicate member	0.32		0.64		0.79		0.68	
Mean standard deviation of daily average maximum	0.67		0.62		0.60		0.79	
Mean standard deviation of daily average minimum	0.82		0.78		0.73		0.85	
Mean standard deviation of daily average precipitation	0.59	0.65	0.59	0.62	0.60	0.61	0.30	0.56
Hydric deficit	0.52		0.51		0.53		0.29	

Table 8. Indexed sub-components, major components, and overall VI to price volatility

Vulnerability price volatility								
Sub-component	SDi	Major Comp	MRO	Major Comp	MI	Major Comp	LMI	Major Comp
Unique income	0.16		0.36		0.23		0.24	
Family members economic dependent	0.26		0.33		0.18		0.20	
Crops diversification (inverse)	0.25	0.44	0.27	0.46	0.21	0.48	0.23	0.43
Direct Sell (inverse)	0.78		0.77		0.82		0.89	
Agro-industry work (inverse)	0.95		0.91		0.80		0.80	
Studies	0.97	0.79	1.00	0.80	0.98	0.82	1.00	0.83
Working experience	0.61		0.44		0.68		0.63	
Age (log)	0.66	0.80	0.44	0.80	0.68	0.78	0.56	0.81
Gender	0.90		1.00		0.96		0.99	
PAC subsidy	0.70		0.91		0.94		0.93	
Modernisation subsidy	0.11		0.52		0.38		0.40	
Irrigation subsidy	0.19	0.18	0.71	0.38	0.60	0.35	0.68	0.33
CUMA subsidy	0.00		0.05		0.06		0.11	
Percentage of owned land	0.35		0.09		0.01		0.19	
Percentage of rented land	0.18		0.06		0.37		0.21	
Internet use	0.39	0.39	0.62	0.62	0.56	0.75	0.76	0.56
Info shared with neighbours	0.88		1.00		0.91		0.97	
Cooperative member	0.79	0.66	0.86	0.83	0.90	0.90	0.93	0.83
Syndicate member	0.32		0.64		0.68		0.79	
Sum of all crops price volatility	0.06	0.01	0.30	0.02	0.05	0.07	0.15	0.05

Table 9. VI to climate variability and drought contributing factors for the four types of livelihoods (IPCC, 2001)

IPCC contributing factors	Small-scale diversified farmers	Medium-scale rainfed organic farmers	Medium-scale intensive farmers	Large-scale intensive farmers
Sensitivity	0.13	0.16	0.17	0.12
Adaptive capacity	0.39	0.52	0.56	0.52
Exposure	0.65	0.62	0.61	0.56
VI_climate	0.035	0.015	0.007	0.005

Table 10. VI to price volatility contributing factors for the four types of livelihoods (IPCC, 2001)

IPCC contributing factors	<i>Small-scale diversified farmers</i>	<i>Medium-scale rainfed organic farmers</i>	<i>Medium-scale intensive farmers</i>	<i>Large-scale intensive farmers</i>
Sensitivity	0.44	0.46	0.48	0.43
Adaptive capacity	0.48	0.61	0.63	0.59
Exposure	0.01	0.02	0.07	0.05
VI_price	-0.20	-0.27	-0.27	-0.24

VIII. Focus group template

Introduction⁸

Thank you very much for your cooperation. I am sure each of you has much to contribute to this workshop and hopefully we can have a discussion in which we can learn from each other.

Joining me today is Imanol Okiñena, a master student and collaborator in the centre where I work, and Begoña Renteria, a social worker and friend.

The objective for the discussion is to better understand the access to irrigation water. To do this, I am interested in the different viewpoints and perspectives regarding the modernisation of irrigation in Miranda de Arga by analysing the comparison of traditional and modern irrigation.

There are rules for the discussion. It is very important to be respectful of taking turns in speaking and adhering to the objectives of the workshop. It is particularly essential to maintain compliance with all participants. Please, let us maintain an environment of respect to everyone throughout the debate.

⁸ All the interviews were conducted in Spanish. Here, the questions are translated to English. If anyone wishes to view the original versions, they are available via the author.

I would appreciate if each participant can take approximately two minutes to introduce themselves and state the reason that each person is here today. I ask for your permission to record it.

Thank you again for contributing.

Traditional and modern system characterisation

The first exercise consists of characterising each irrigation system. Please write down a brief description on the provided card focusing on the given categories:

- Monitoring, surveillance and penalties regarding the proper management of irrigation water. How is this influenced/will influence the behaviour of users/biophysical conditions and its effect on irrigation farmer relations (cooperation, dependency).
- Is the distribution of benefits and cost (rights and duties) properly balanced between irrigation farmers and/or external actors (concessionary company, Navarre Government, etc.)?
- Water consumption (efficiency and effectiveness of the irrigation system)
- Prices (commodification of land and water)
- Community, insurance-related subsidies that may potentially favour some groups
- Others

Each participant will fill out their cards and place them with the corresponding topics, in the panels of traditional and modern irrigation systems. We will compare both irrigation systems. Finally, a brief descriptive summary will be made, followed by the debate.

Advantages and disadvantages of both modern and traditional systems

Now we will discuss some advantages and disadvantages of both systems. Respective to the topics from the previous exercise, we will examine a few related variables: social, economic, environmental, cultural and political aspects (empowerment, disempowerment).

In the following panel we will document the advantages and disadvantages of the ideas discussed in the previous exercise. We must specify what kind of benefits they are (economic, environmental, etc.) and which group (among the different types of farmers) is either positively or negatively affected. Advantages and disadvantages may be related to three different types of farmers⁹, which are representative of the different livelihoods in *Itoiz-Canal de Navarra* zone.

Everyone has 10 min to think and then participants will stand up to draw up your ideas (represented by cards) and placed at each point you want to discuss.

⁹ I did not distinguish between large-scale and medium-scale intensive farmers and both were discussed as belonging to the same group.

Break

Summary of the debate

Discussion focus on the effect of the advantages and disadvantages among the plurality of actors involved: smallholders, intensive farmers, organic farmers.

List of participants and brief description

Here are the profiles of the focus group participants who were involved.

	Profile
FG.1	INTIA technician in charge of the <i>concentración de tierras</i>
FG.2	Land-holder in favour of traditional irrigation
FG.3	Miranda de Arga neighbour, sustainable fluvial manager and member of the foundation <i>Nueva Cultura del Agua</i>
FG.4	Miranda de Arga <i>intensive</i> farmer
FG.5	Miranda de Arga <i>organic</i> farmer

Note: This focus group was conducted in June 2015 in Miranda de Arga

IX. Characteristics of farmers livelihoods profiles

Here is a summary of the main characteristics of farmers' livelihood profiles (Albizua 2016).

Table 11. Characterisation of the clusters regarding farmers' land use management (N=364)

Key variables to characterise clusters of farmers	Cla/Mod	Mod/Cla	v-test
Small scale diversified farmers (N=125)			
No irrigated maize conventionally fertilised	64.80	92.80	12.72
No irrigated (other) cereal conventionally fertilised	75.00	76.80	12.11
No irrigated maize (0 Ha)	64.50	87.20	11.66
No rainfed cereal (0 Ha)	74.51	60.80	9.94
Low surface (0-5 Ha) of irrigated 'other' crops	69.51	45.60	7.42
No irrigated cereal (0 Ha)	47.23	88.80	7.33
Conventionally fertilised irrigated 'other' crops	64.20	39.69	5.86
Medium scale organic farmers (N=22)			
Organic fertilised rainfed cereal	100.00	68.18	9.56
Organic fertilised rainfed vineyard	100.00	40.91	7.05
Low surface (0-5 Ha) of rainfed vineyard	23.53	36.36	3.57
Organic fertilised irrigated maize	50.00	18.18	3.42
Organic fertilised irrigated 'other' crops	23.08	27.27	2.98
Low surface (>5 Ha) of rainfed vineyard	23.81	22.73	2.74
Large-scale intensive farmers (N=86)			
Mixed fertilised rainfed cereal	83.05	56.98	10.81
Mixed fertilised irrigated maize	67.95	61.63	9.71
Quite extend area (75 Ha) of rainfed cereal	60.61	46.51	7.23
Quite extend area (>50Ha) of irrigated maize	63.33	22.09	4.81
Medium scale intensive farmers (N=131)			
Conventionally fertilised irrigated maize	81.82	61.83	11.11
Conventionally fertilised rainfed cereal	64.20	79.39	10.21
Conventionally fertilised irrigated cereal	85.71	50.38	10.18
No rainfed 'others' (0 Ha)	42.47	96.95	6.04
Medium area of irrigated maize (10-50 Ha)	55.10	41.22	4.52
Small area of irrigated maize (5-10 Ha)	69.23	20.61	4.42
Small area of rainfed cereal (10-50 Ha)	54.02	35.88	3.93

Note: The mode is the value that appears most often in a set of data, in this case Cla/Mod refers to the part of the total population that is in the cluster. Mod/Cla refers to the most recurring value in the cluster. If the v-test (last column) is positive, it indicates that the category is over-expressed for the category; if the v-test is negative, it means that the category is under-expressed for the category. The v-test indicates the size differences between class and mode: the larger the number, the higher the representation of that variable is in the given cluster (in comparison to other clusters).

Table 12 Farming livelihoods across villages

Farming livelihoods	North	Medium	South
Small scale diversified farmers (N=125)	54	44	27
Medium scale organic farmers (N=22)	6	12	4
Large-scale intensive farmers (N=86)	30	39	17
Medium scale intensive farmers (N=131)	21	40	70