Supplementary material

Table S1. Changes to foster a transition towards sustainable cattle ranching in the region of Los Tuxtlas, identified by members from academic (Acad), productive (Produc_), social (NGO) and government (Gov) sectors during participatory workshops. The last column corresponds to the trajectory of change assigned to the different nodes.

Node num.	Change	Gov Sec	NGO Sec	Produc Sec	Acad Sec	Change Trajectory
1	Improvement in the producer´s economy				X	Convergence of the three trajectories
2	Livestock is business	X		X		Convergence of the three trajectories
3	There is a local, regional and national market interested in sustainable livestock products			X	X	Convergence of the three trajectories
4	There is greater availability of water and biodiversity, which improves the productivity in ranches	X		X		T1
5	Social recognition of sustainable livestock farming				X	Convergence of the three trajectories
6	Sustainable livestock products have value-added	X	X	X	X	Convergence of the three trajectories
7	Diversification in agroecological production			X	X	T1

8	There is healthcare and traceability in the agricultural value chain	X				T3
9	Producers have animal health control practices			X		T3
10	Population is interested in buying sustainable livestock products			X	X	Convergence of the three trajectories
11	There is economic remuneration according to the work performed			X		Convergence of the three trajectories
12	There is a critical mass of producers who demand health and traceability programs	X			X	T3
13	There is a cooperative of sustainable livestock products	X	X	X		Convergence of the three trajectories
14	Expenditure on inputs is reduced		X			Convergence of the three trajectories
15	Producers in the region effectively and widely implement good livestock practices		X			T1
16	There is co-responsibility between industry, state, academia and organizations to implement health and traceability programs	X				T3
17	There are capacities for the promotion, implementation and management of sustainable livestock production systems in technicians, producers, academics and other relevant actors.	X			X	T2, T3

18	There are public policies to promote sustainable livestock practices	X	X	X		T3
19	There is dissemination of information about sustainable livestock farming at regional level	X	X	X		T2
20	There are producers and people who are convinced and motivated to adopt agrosilvopastoral and restoration practices			X	X	T2
21	There is a manual of good practices for producers who want to implement them			X		T2
22	There is a network of technicians trained in sustainable livestock farming			X	X	T3
23	There is constant training for the staff and ranchers	X	X	X	X	T3
24	There is financial support			X	X	T3
25	There are plots and demonstration ranches that carry out sustainable practices.			X	X	T2
26	Livestock associations and unions promote sustainable livestock production systems	X	X	X	X	T2
27	There is a program/career for technical training in sustainable livestock farming	X			X	T3
28	There are herbicide-free zones	X				T1

29	In the ranches, the infrastructure for the provision of water for livestock has been solved, avoiding contamination	X	X			T1
30	There is greater vegetation cover and availability of good quality water	X	X			T1
31	Small hydrological basins have been identified on the ranches and are protected by planting native trees to prevent erosion.	X	X			T1
32	There are trees around water sources (ecological restoration corridors in rivers)	X		X		T1
33	Each ranch can supply its own water	X		X		T1
34	Water available for livestock does not compete with water for human populations	X	X			T1
35	Definition of strategic zones for water security and conservation of biodiversity in the region				X	T1
36	Diversification of forage shrubs and trees, as well as legumes	X	X	X		T1
37	Farmers have livestock rotation systems	X	X			T1
38	Local networks for learning and promoting sustainable livestock production systems				X	T2
39	There is planning for the ranches	X	X	X		T1

40	There is extensive dissemination of sustainable livestock practices: forums and exchange of farmer-livestock experiences	X	X	X	X	T2
41	There is a group of innovative producers interested in sustainable livestock farming				X	T2
42	Interested producers are identified	X	X		X	T2
43	Local communities understand and are aware of the importance of changing towards sustainable livestock practices			X		T2
44	There is a desire to change each ranch			X		T2
45	There are places to produce and grow up shrubs and trees	X	X			T1

6

7

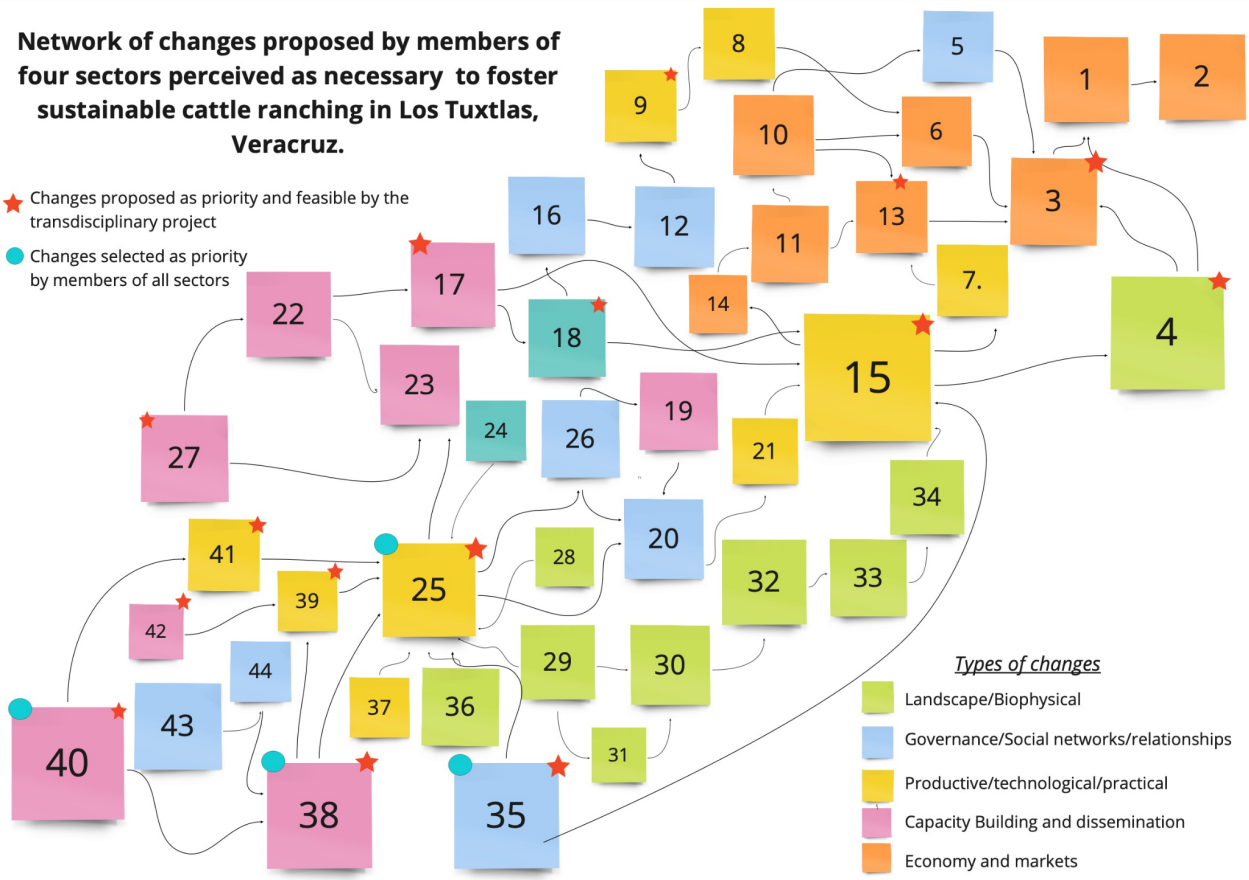

Figure S1. Summarized network of changes to foster sustainable cattle ranching, resulting from the five online workshops with members of academia, NGO´s, governments and livestock producers from the region of Los Tuxtlas, Veracruz. Numbers correspond to the changes described in table S1. Red stars depict those changes considered by participants as more relevant with regards to the collective's potential incidence, blue circles indicate those changes in which the four sectors coincided as the most relevant to initiate the project.

Details of the network analysis

The different nodes of sub-network A were organized directly or indirectly around the change 'There are demonstration ranches that carry out sustainable agricultural practices' (node 25). Most of the changes connected to this central node related to practical or governance dimensions. There was only one set of changes that were connected in sequence and impinged on the change ' implementation of demonstration ranches' (node 25). This thematic strand/action routes referred to the importance of local communities' understanding, values, and willingness to change towards sustainable farming practices, which is reflected in a network of learning and promotion of such production systems (nodes 43, 44, 38). Noteworthy, these changes were proposed by the group of producers and not by any other sector. Within this sub-network, two sets of changes are worth mentioning because each one represents an idea. The first set of changes focused on the motivation of producers to adopt silvopastoral production and ecological restoration practices, and their diffusion within the cattle ranching regional unions (nodes 26, 19 and 20). These changes were derived from the existence of demonstration ranches (node 25), where interested people could learn how to implement sustainable cattle ranching practices. The other set of changes were related to education and capacity building in sustainable livestock farming, supported by technical training programs and careers, continuous training programs and a network of technical experts in these practices (nodes 22, 23 and 27).

The second sub-network (B) focused on implementing sustainable practices, the emergence of a market for sustainable livestock products, and the appreciation of society for the benefits of sustainable cattle ranching. This set of changes initially required the need for regional producers to effectively and widely implement sustainable food livestock farming practices (node 15). This was an intermediary change, but required many previous changes (some of them belong to sub-network A, as explained below). To have a generalized implementation of sustainable cattle ranching practices, a shared responsibility between the different sectors to implement health and traceability programs is required (node 16), as well as the existence of local capacities for promoting and implementing sustainable production systems between actors from different sectors (node 17). Some other suggested changes included the creation of public policies supporting sustainable livestock production (node 18), together with a handbook of sustainable cattle ranching (node 21). The fulfillment of the change that producers in the region effectively and widely implement good livestock husbandry practices (node 15) was perceived as necessary for the generation of local markets and cooperatives, fostering a positive economic impact of livestock production and a broader interest of society in sustainable livestock products. On the one hand, these changes could have an impact on the reduction of input costs (node 14), with a positive impact on economic remuneration according to the work done (node 11), which could further increase population's interest in buying sustainable livestock products (node 10).

A second strand of sub-network B consisted of changes mainly related to the existence of local, regional and national markets interested in sustainable livestock products (node 3). This change

relied on the existence of a cooperative for sustainable livestock products (node 13), as well as on greater availability of water and biodiversity, which would improve the productivity of the ranches (node 4), on the social recognition of sustainable livestock farming (node 5) and the added value of sustainable livestock products (node 6). This last change was relevant as all four participating sectors agreed on it. The network shows that for this change, it would be necessary to implement changes that again refer to the co-responsibility of the different sectors (node 16), the need to have a critical mass of producers requesting health and traceability programmes (node 12), producers implementing livestock health control practices (node 9) with a good traceability, resulting in added value of livestock products (node 8).

Finally, the changes connecting sub-network A with sub-network B included two thematic *bridges*, and although they have different origins in sub-network A, they all connect to the node 15 (effective and widespread implementation of good livestock farming practices by producers in the region) in sub-network B. One of these bridges, node 17 consisting in capacity building on sustainable cattle ranching across sectors requires the consolidation of a network of technicians trained in sustainable livestock production (node 22), to then promote this expertise in effective and widespread implementation of sustainable cattle ranching (node 15). The second bridge connects the farmers' belief in agroforestry and restoration practices (node 20) with the widespread implementation of good livestock practices (node 15), through node 21, the personal conviction influencing the existence of good practices for producers willing to change their cattle ranching practices. Finally, one change that does not strictly represents a bridge but influenced both sub-networks is node 35, the need to define strategic zones for the

region's water security and biodiversity conservation prior to the consolidation of demonstration ranches (node 25) and the widespread implementation of sustainable livestock practices (node 15).

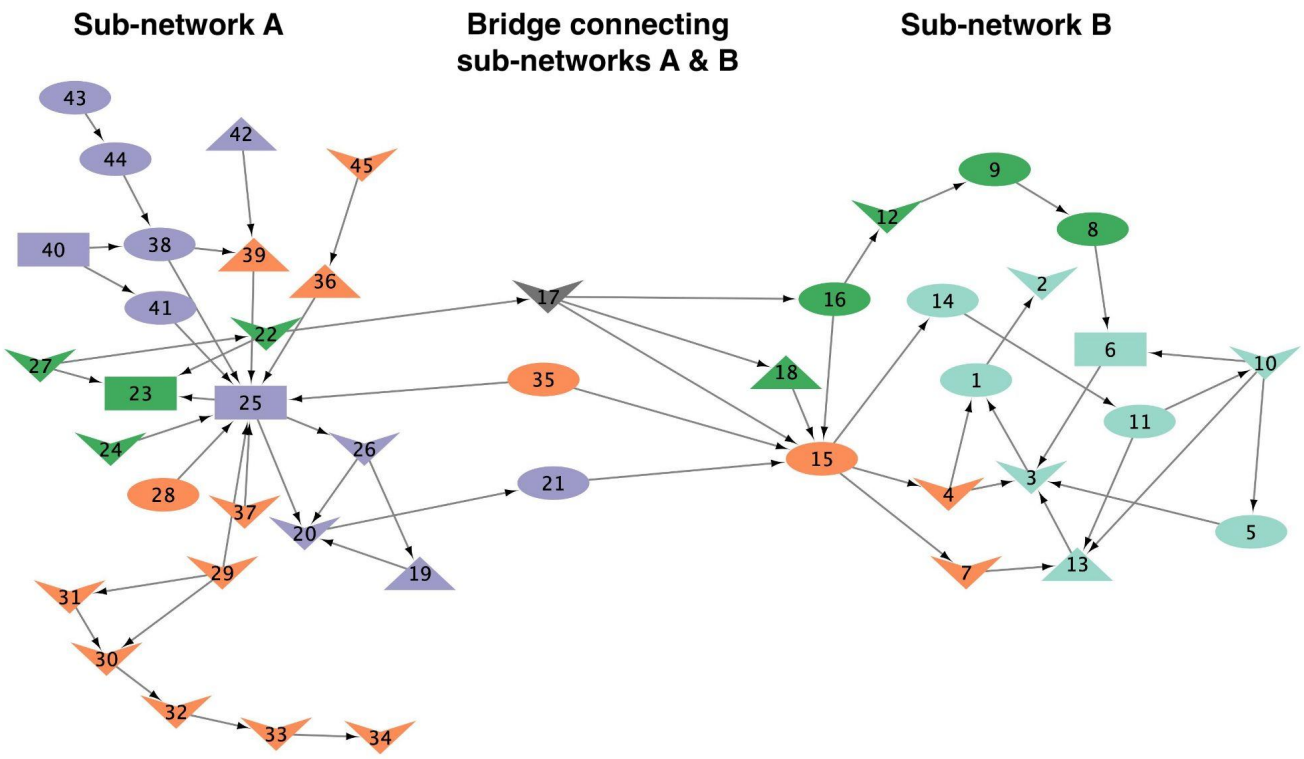

Figure S2. Description of the network of changes proposed by participants as necessary to foster sustainable cattle ranching in the region of Los Tuxtlas, Veracruz. Node shapes denote the number of social sectors that suggested a particular change (Circle= 1, Arrow= 2, Triangle = 3, Square= 4), colors identify the three trajectories (trajectory 1 is orange; trajectory 2 is purple; trajectory 3 is green; in node 17 trajectories 2 and 3 converge, it is gray; and nodes where the three trajectories converge are color light green), summarizing the changes needed to i) situate territorial strategies (blue), ii) consolidate alliances and promote the exchange of local experiences and iii) promote training programs and public policies towards sustainable cattle ranching.