sustainability

MDPI

Article

Livelihood Capitals, Income Inequality, and the Perception of Climate Change: A Case Study of Small-Scale Cattle Farmers in the Ecuadorian Andes

Bolier Torres [1,2,3,*], Jhenny Cayambe [4], Susana Paz [1], Kelly Ayerve [1], Marco Heredia-R [3,5], Emma Torres [5], Marcelo Luna [6], Theofilos Toulkeridis [7] and Antón García [2]

[1] Facultad de Ciencias de la Vida, Universidad Estatal Amazónica (UEA), Pastaza 160101, Ecuador; susana97paz@gmail.com (S.P.); kellyayerve@hotmail.com (K.A.)
[2] Departamento de Producción Animal, Facultad de Ciencias Veterinarias, Universidad de Córdoba, 14071 Córdoba, Spain; pa1gamaa@uco.es
[3] Corporación para el Desarrollo Sostenible, Conservación y Cambio Climático (DSC), Tena 150150, Ecuador; mageher@gmail.com
[4] School of Agricultural and Environmental Sciences, Pontificia Universidad Católica del Ecuador Sede Ibarra (PUCESI), Imbabura 100112, Ecuador; jmcayambe@pucesi.edu.ec
[5] Facultad de Ciencias Agropecuarias, Universidad Técnica Estatal de Quevedo (UTEQ), Quevedo Av. Quito km, 1 1/2 vía a Santo Domingo de los Tsáchilas, Quevedo 120550, Ecuador; etorres@uteq.edu.ec
[6] Departamento de Ciencias de la Tierra, Universidad Estatal Amazónica (UEA), Pastaza 160101, Ecuador; mluna@uea.edu.ec
[7] Departamento de Ciencias de la Tierra y Construcción, Universidad de las Fuerzas Armadas ESPE, Sangolquí 171103, Ecuador; ttoulkeridis@espe.edu.ec
* Correspondence: btorres@uea.edu.ec

Citation: Torres, B.; Cayambe, J.; Paz, S.; Ayerve, K.; Heredia-R, M.; Torres, E.; Luna, M.; Toulkeridis, T.; García, A. Livelihood Capitals, Income Inequality, and the Perception of Climate Change: A Case Study of Small-Scale Cattle Farmers in the Ecuadorian Andes. *Sustainability* **2022**, *14*, 5028. https://doi.org/10.3390/su14095028

Academic Editors: Irfan Ahmad Baig and Nasir Mahmood

Received: 4 March 2022
Accepted: 20 April 2022
Published: 22 April 2022

Abstract: The Sustainable Development Goals (SDG) of 2015 identify poverty, growth, and inequality as three key areas of intervention towards the UN 2030 Agenda for human well-being and sustainability. Herein, the predominant objectives are: (a) To determine the poverty groups by quintiles through the cattle income in households of small milk producers; (b) To characterize rural livelihoods by using capital theory; and (c) To assess the perception of climate change (CC) and the willingness to accept adaptation as well as mitigation measures. The current study was performed in communities that are located in the Ecuadorian Andes, where some 178 surveys were conducted with indigenous Kichwa and mestizo heads of households. From the total net income determined, five groups were organized. The Lorenz curve was applied as a general indicator of the relative inequality, as well as the Gini coefficient (G). On the basis of the theory of capital, the human, social, natural, physical, and financial characteristics were determined, and seven variables were considered to evaluate the perception and willingness to accept mitigation and adaptation actions of the given quintiles. The result of the Gini coefficient was 0.52, which indicates that the poorest 20% of the population only receives 3.40% of the income, while the richest 20% of the quintile obtain about 54% of the total income. It is evident that most producers know little about CC, but that they are willing to receive strengthening programs. Therefore, it is essential to establish strategic guidelines from public policy in order to reduce inequality and to improve the social welfare of producers, with a transversal axis in the strengthening of the capacities on the impact, mitigation, and adaptation to CC, as well as the provision of several tools, such as access to climate information.

Keywords: indigenous; poverty; inequality; climate change; Lorenz curve

1. Introduction

Livelihoods can be defined as a measure of the set of actions that are taken by people, within their capacity and capital, to earn a living by maintaining a highly diverse portfolio of activities, while livelihood capitals encompass the natural, physical, human, social, and financial resources that are critical to the survival of people in response to stresses and shocks, without damaging the natural resource base [1–4]. Livelihoods involve not only the activities that shape the way that people live, but also the resources that ensure a satisfying life, the risk involved in managing those resources, and the policies that support or oppose the pursuit of livelihoods and good living [2]. Subsistence capitals can be stored, exchanged, and transferred in the process of generating income for the household [4–9].

The important role of conventional agricultural strategies (e.g., agriculture, forestry, and livestock) in reducing poverty is pointed out by the authors of [10–15], who argue that the increase in the area of arable land, the development of agricultural products with high added value, the adjustment of the structure of agricultural production, the improvement of the productivity of the land, and the fulfillment of the basic requirements for agricultural activities would produce less poverty. In the central Ecuadorian Amazon, it was determined that the livestock-based livelihood strategy was more successful in economic terms than others that are oriented towards agriculture and forest use [16,17], with the recommendation of 16 livestock best-management practices that are aimed at climate-change adaptation and mitigation as actions to strengthen the livelihoods of cattle-raising households [18]. In addition to the insights that are inherent in perception processes, climate-change impacts are increasingly recognized as important drivers of livelihood strategies that are, in particular, effective linkages with the livelihood vulnerability and the alleviation of poverty [19–21]. Climate change is an additional burden on poor people, who are already vulnerable and excluded, and there are predictions of additional risks to livelihoods and greater inequity in the future [22].

Poverty is a complex economic phenomenon that occurs when the income of individuals or households falls short of basic living standards [22,23] because of the deprivation of access to social, economic, and political resources to achieve adequate food, the use of drinking water and sanitation, among many others [24,25]. These circumstances may be divided into absolute and relative poverty [26,27], chronic or persistent and transitory poverty [28,29], regional (place) and individual (people) poverty [30–34], as well as urban and rural poverty [35,36]. Regional poverty is a chronic or persistent poverty, while individual poverty is transitory [24]. Individual poverty is closely related to regional poverty, and they influence and interact with each other. Regional poverty usually leads to the lack of an endogenous impulse for the individual development of a region; in turn, individual poverty translates into slow socioeconomic development and the lack of infrastructure and the guarantee of public services throughout the region, which accumulates as regional poverty [24,37–40]. Both individual and regional poverty are affected by human, social, financial, physical, natural, and livelihood capitals, as well as by their synthetic geographic capital, while these poverty-influencing factors vary across time scales and geographic regions [37,38].

Approximately 80% of the world's poor live in rural areas [41]. Reducing their multidimensional vulnerability needs to be a local, national, and international priority [42–44], and, in this way, may comply with the indicators and goals of SDG 1, which shall lead to the eradication of poverty, and SDG 2, which may lead to the achievement of food and nutrition security and the end of hunger, as described in the UN Sustainable Development Goals for 2030 [44]. This accomplishes a better mitigation of the rural gap of urban contexts [45,46]. A key route out of rural poverty is to improve the productivity, profitability, and sustainability of small-scale production systems [47–49]. Scientific evidence from specific geographic and social contexts is needed in order to inform the implementation of effective instruments that target vulnerable smallholder farmers [50–52]. Human security relates to the social order in its concern for stability, as well as to the levels in the key dimensions of human development, which include freedom from misery and fear [53].

The geographic elements that affect poverty include location, resource endowment, the ecological environment, public service, regional politics, and culture [54–56]. Previous studies have indicated that there is a "downward spiral" between regional impoverishment and environmental degradation [57–65]. The remote geographic location is often considered to be the main cause of the high incidence in the semiarid region of Zimbabwe [66]. Even in developed countries, such as the United States and Great Britain, rural impoverishment and geographic locations are closely related, and the incidence of poverty increases with the distance from metropolitan areas [67]. In China, ecologically fragile areas largely overlap with poor areas [68]. In addition, the topographical conditions, the slope, the surface fragmentation, the distance/travel time to public resources or services, the elevation, and the type of land use are also closely related to poverty [54,69–73]. Complex topography has a positive driving effect on the spatial distribution of poverty-stricken countries [72]. Natural conditions play a scale-independent role in the incidence of poverty [71]. Soil erosion can affect the quality of agricultural land, which forms a vicious cycle of ecological damage, soil erosion, the shrinkage of arable land, impoverishment, the reclamation of steep slopes, and ecological degradation [36]. Natural disasters and climate change are also considered to be driving forces of rural impoverishment [64,74–77]. Natural disasters perpetuate poverty and make it difficult for poor people to escape it [78–83]. Globally, natural disasters force around 26 million people into extreme poverty each year [76,78]. By 2030, around 325 million extremely poor people are expected to live in the 49 most hazard-prone countries in the world, with most of them in South Asia, sub-Saharan Africa, Latin America, and the Caribbean [84].

In this context, the objectives of the current study were three-fold: to determine the poverty groups by quintiles through cattle income and inequality by using the Gini coefficient and the Lorenz curve in the households of small milk producers, to characterize rural livelihoods by using the theory of capitals and by evaluating the perception of climate change, and to evaluate the readiness to accept adaptation and mitigation measures.

2. Materials and Methods

2.1. Study Area

The present study was performed in four livestock communities in the Tungurahua and Chimborazo provinces, which are located in the biogeographical region of the Andes mountain range in central Ecuador (Figure 1). The communities of Pilahuín and Tamboloma belong to the Pilahuín parish (42,156 ha), which is located to the southwest of the Ambato canton in the province of Tungurahua. On the other hand, the San Rafael and Chuquipogyo communities in the San Andrés parish (159,900 ha) are located in the central highlands of the country, northwest of the Guano canton, within the province of Chimborazo. The predominant bioclimatic floor is the high montane, while the temperatures range between 0 and 14 °C, with an average annual rainfall of about 1142 mm [85].

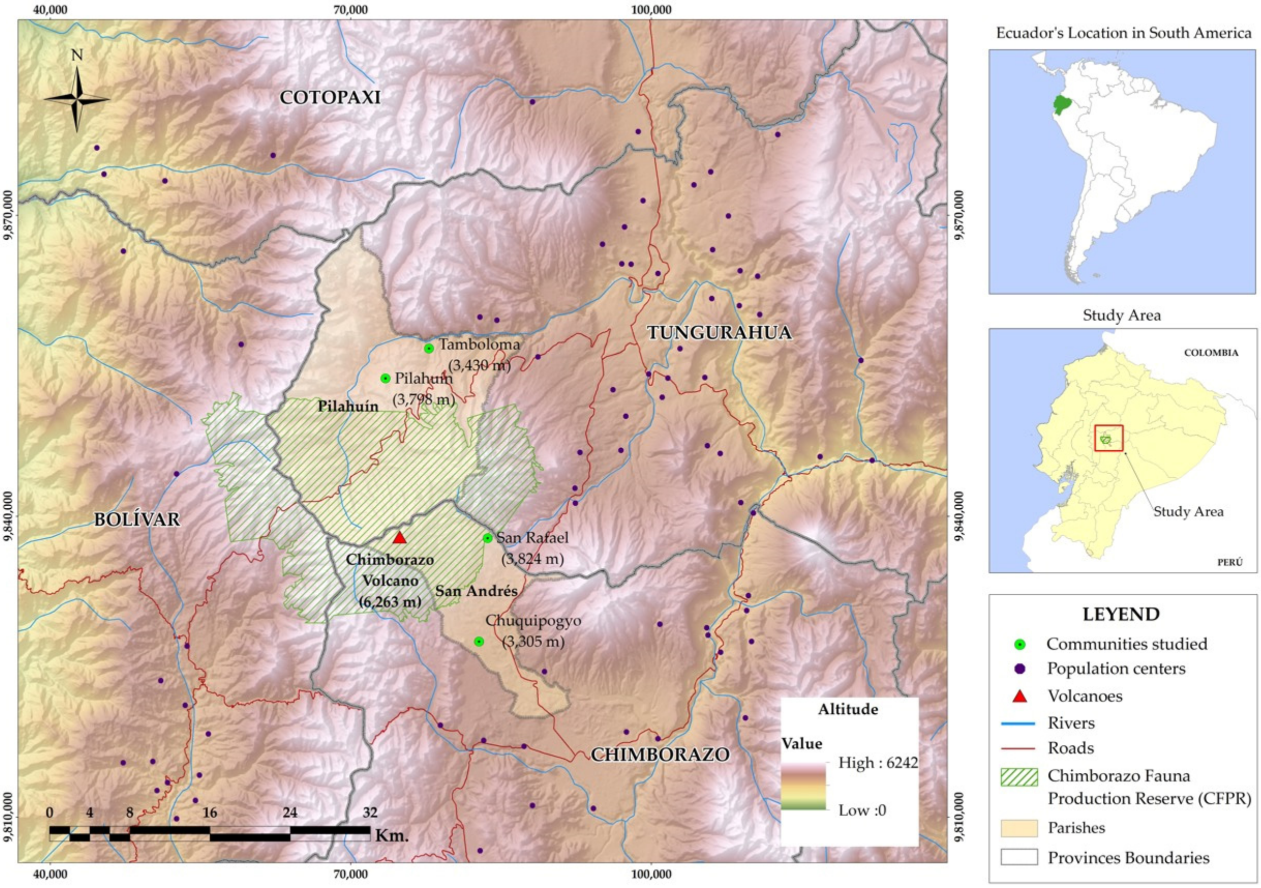

Figure 1. Pilahuín, Tamboloma San Rafael, and Chuquipogyo communities located in the Pilahuín and San Andrés parishes, within the Ecuadorian Andes.

Some 49 and 39.4% of the territory of the Pilahuin and San Andrés parishes, respectively, are within the National System of Protected Areas (SNAP) [86]. They overlap in the Chimborazo Fauna Production Reserve (CFPR), which was created under Ministerial Agreement No. 437 of 26 October 1987, which extended to an area of some 58,560 ha [87,88]. The CFPR is distributed among three provinces, six cantons, and nine parishes (Table 1).

Table 1. Administrative distribution of the Chimborazo Fauna Production Reserve (RPFC), in the Ecuadorian Andes.

Provinces	Cantons	Parishes	Meters above Sea Level m.a.s.l.
Chimborazo	Riobamba	San Juan	3200
	Guano	San Andrés	6310
Tungurahua	Ambato	Pilahuin	3480
		Juan Benigno Vela	3016
	Tisaleo	Tisaleo	3320
	Mocha	Mocha	3280
Bolívar	Guaranda	Simiatug	3238
		Salinas	3536
		Guanujo	2920

2.2. Data Collection and Statistical Analysis

We conducted 197 surveys on small ranchers in four communities, from which those with between one and twenty head of cattle were chosen. A total of 19 producers that did not meet these characteristics were eliminated, and we finally continued with a sample of 178 cases. The selected small ranchers were distributed with 49 in Pilahuín, 45 in Tamboloma, 48 in San Rafael, and 36 in Chuquipogyo. For the grouping of small ranchers by poverty quintiles, the income and costs of the cattle-ranching activities at the household level were determined. Subsequently, the theory of capitals and climate change grouped by quintiles was analyzed.

Thereafter, a total of 178 cattle farms were analyzed for a variety of parameters. Prior to the statistical analyses, the normality of the data distribution was evaluated by using the Kolmogorov–Smirnov test, including the Lilliefors correction [89,90]. For those variables that did not demonstrate normal distributions, the Bartlett test was applied in order to assess whether the data had equal variances [91]. The quantitative variables were compared by using the analysis of variance (ANOVA) and establishing the Quintiles as a fixed effect (from 1 to 5 levels) [92]. For the comparison of the means, the Tukey method was used. Likewise, the $\chi2$ test ($p \leq 0.05$) was used for the qualitative variables. Statistical 12.0 for Windows software was applied to perform the statistical analyses, and the SPSS statistical program was used for the analysis of the descriptive statistics, such as the standard deviations, averages, percentages, and frequencies.

2.3. Determination of Net Income and Poverty Groups by Quintiles

To determine the net income, calculations were conducted of all the income from cattle activities at the household level, from which all of the costs that were incurred in activities related to cattle farming were subtracted. Furthermore, we used quintiles to group the subjects into several equal groups, as quintiles are frequently used in economic and social analyses and they allow the establishment of inequality metrics. The quintile facilitates the classification of the population according to income, with homogeneous values within the group, and heterogeneous values between them [93–95]. Thus, from all of the households surveyed, the total net income of each household was calculated, and they were arranged into five groups according to their income, in ascending order. This occurred in such a way that Quintile 1 corresponds to the 20 percent of the people with the lowest income, and the fifth quintile to the 20% with the highest income.

- Quintile 1 (Q1): value that is higher than the 20% of the lowest samples;
- Quintile 2 (Q2): value that is higher than the 40% of the lowest samples;
- Quintile 3 (Q3): value that is higher than the 60% of the lowest samples;
- Quintile 4 (Q4): value that is higher than the 80% of the lowest samples;
- Quintile 5 (Q5): corresponds to the highest value.

$$Q_q = L_i + \frac{q\binom{n}{5} - Ni - 1}{n_i} * a \quad (1)$$

With q = 1,2,3,4

where:
L_i is the lower real limit of the class of the quintile (q);
N is the number of data;
$Ni - 1$ is the cumulative frequency of the class that precedes the class of the quintile (q);
n_i is the frequency of the class of the quintile (q);
a is the length of the class interval of the quintile (q).

In order to determine and categorize the poverty, we first used the recommendation from the INEC [96], who suggest comparing the per capita household income with the poverty line and with extreme poverty, which, in the month of June 2018, were USD 84.72 and USD 47.74 per month per person, respectively. In this framework, households with individuals whose per capita income is below the poverty line (USD 2.82 per day) are reported and are considered poor, and if it is below the extreme poverty line, they are considered extremely poor (USD 159 per day). Secondly, we named the poverty groups according to the five categories (quintiles) as extremely poor (Q1), moderately poor (Q2), not so well-off (Q3), moderately well-off (Q4), and well-off (Q5).

2.4. Income Inequality (Gini Index and Lorenz Curve)

For the determination of the income inequality, the Lorenz curve was used as a general indicator of the relative inequality [97,98], which allowed for a graphic representation of the income distribution. The Gini coefficient (G) was also determined to support the results. The Gini measure is defined as the area that is closed by a diagonal, while the Lorenz curve is expressed as a proportion of the area under the diagonal [91], where a coefficient close to 1 means extreme inequality, and 0 represents complete equilibrium, which means that everyone earns the same.

The original formula appears in various forms, but it can be calculated from the Lorenz curve as the ratio, and can be represented in the following equation: G = Area A/(Area A + Area B). For the current study, we followed the following formula:

$$G = 1 - \sum_{i=0}^{N} (\sigma Y_{i-1} + \sigma Y_i)(\sigma X_{i-1} + \sigma X_i) \quad (2)$$

where σX and σY are the cumulative percentages of the Xs and Ys (in fractions), and N is the total number of households.

For the study of the income from the cattle activity by quintiles, the following variables were analyzed: (1) The average income from milk sales, which refers to the production for sale in the collection center; (2) The average valuation per calf, which indicates the milk production for raising the calves owned by the rancher; (3) The average total cattle income, which is the sum of both the income from the sale of milk and the valuation per calf; (4) The average household size, which allows a reference to the amount of members that a household has living under the same roof; (5) The average per capita/daily income, which refers to all the economic income that is received by a household; (6) The category according to the INEC [96], which is a variable that defines the grouping of the households surveyed; and finally (7) The percentage of the sample.

2.5. Characterization of Rural Livelihoods Using the Theory of Capitals

The rural livelihoods were characterized by using the socioeconomic variables that correspond to the five capitals (human, social, natural, financial, and physical). Details of the variables used are listed in Table 2. Herein, in the analysis of human and social capital, the following variables were used: (1) Ethnicity, in order to obtain knowledge about the type of Kichwa and Mestizo nationality that the surveyed households belong to; (2) The gender of the head of the household, which indicates which gender predominates more in the study site; (3) The age of the head of the household, as this variable is fundamental to determine the age of the so-called head of the household; (4) The education of the head of the household, which is a necessary variable, as analyzing the degree of education allows for an understanding of how aware that person is of the issues of the current research; (5) The replacement generation, which is crucial since it reveals the existence of the heir after the death of the head of household, independent of the gender, who will continue the livestock legacy; and (6) Whether they belong to an agrarian association, which is substantial since it is a strategy of where and how they work together in order to reach a common goal.

Table 2. Topics and variables studied in capital theory.

Topic	Variables
Human and social capital	Ethnicity, gender, age, and education of the household head, successor generation, and association membership.
Natural capital	Total farm area, pasture area, crop area.
Physical and financial capital	Total number of animals per head, total number of cows in production per head, availability of milking water, type of milking floors, container that moves the milk, who performs the milking, and who receives a bonus from the state.

For the study of the natural capital, three variables were analyzed, which included: first, the total farm area (ha), as this refers to the number of hectares each farm has; and second, the pasture area (ha), which refers to the surface area that is occupied by grass; and finally, the cultivation area (ha).

In order to calculate the physical and financial capitals, the following variables were used: (1) The total number of animals per head, which refers to the total number of cattle owned by the small producers; (2) The total number of production cows per head, which reflects the milk yield; (3) The milking water, which consists of the amount of water used in the livestock activity; (4) The type of milking floor, as this variable allows for the identification of where the milking takes place; (5) The milk container, which indicates what type of container is used for milking; (6) Who performs the milking, as this variable is essential to the identification of which gender predominates; and (7) Who receives a bonus, as this corresponds to the beneficiaries by the government.

2.6. Perception of Climate Change (CC) and Readiness to Accept Adaptation and Mitigation Actions

Depending on the groups by quintiles, the variables that are detailed in Table 3 were analyzed. These include seven different variables and the corresponding options of responses.

Table 3. Variables for climate-change analysis.

Id	Variables	Options
1	Understanding about climate change.	1: yes; 2: no; 3: some
2	Does the weather change in your area?	1: yes, a lot; 2: yes, a little: 3: no; 4: unsure
3	Willingness to receive climate-change training.	1: yes; 0: no
4	Willingness to adopt appropriate cattle-management practices.	1: yes; 0: no
5	Access to climatological information.	1: yes; 0: no
6	In the last ten years, have you adopted adaptive actions to climate change?	1: yes; 0: no
7	Willingness to invest labor and materials to adopt actions adapting to climate change.	1: yes; 0: no

3. Results and Discussion

3.1. Determination of Poverty Groups by Quintiles through Cattle Income

In relation to the first quintile (Q1), an annual average of USD 1174.26 was obtained, with a standard deviation of ±595.98. These were 103 households that were in a state of extreme poverty, which represented around 58% of the total of 178 households that were surveyed from the four communities that were studied in the provinces of Chimborazo and Tungurahua (Figure 2). Similar scenarios appear to the small ranchers of Puno (Peru)

[99], Ethiopia [100], and in the semiarid region of South Africa. There poor households are trapped in a state of food insecurity and perpetual vulnerability because of poor asset endowments and a lack of markets, and especially capital, which prevents the necessary investment and the proper and productive use of assets [101,102].

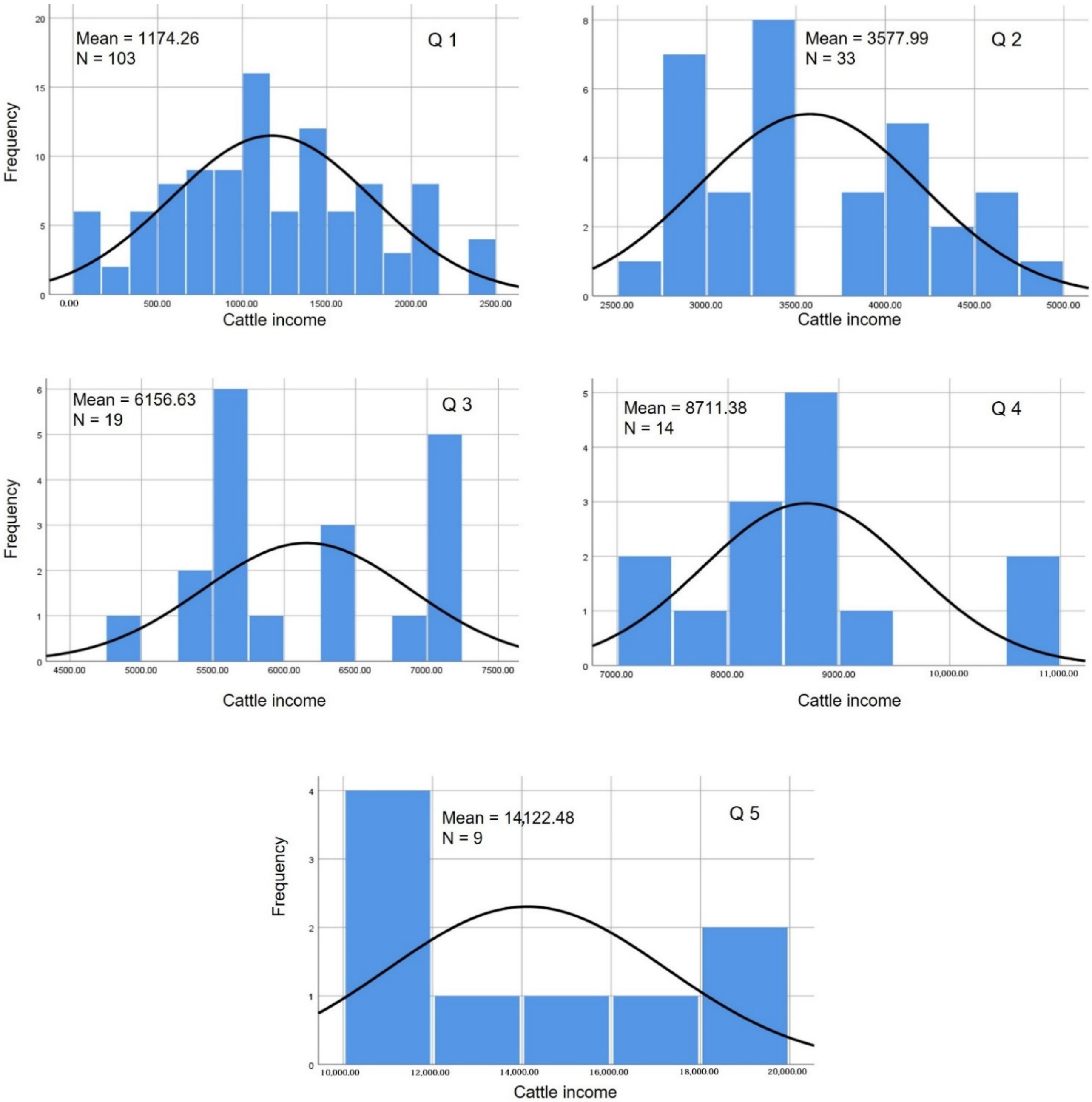

Figure 2. Total livestock income with respect to poverty quintiles in small ranchers in the Ecuadorian Andes.

With regard to the second quintile (Q2), an annual average of USD 3577.99 was obtained, with a standard deviation of ±624.30, which has been assigned to 33 individuals, who represent 18% of the total of the 178 households surveyed. With regard to the third quintile (Q3), an annual average of USD 6156.63 was obtained, with a standard deviation of ±727.35, which represents around 11%. In terms of the fourth quintile (Q4), an annual average of USD 8711.38 was obtained, with a standard deviation of ±940.03, which is 8% of the sample population, while, for the fifth quintile (Q5), an annual average of USD 14,122 was obtained, with a standard deviation of ±3115.40. In this quintile, there were nine of the wealthiest individuals, who only represent around 5% of the total of 178 households that were surveyed from the four communities that were studied in the provinces of Chimborazo and Tungurahua in central Ecuador. This reflects an economic gap between small dairy farmers, for which it is essential to identify the critical points on productive sustainability [18]. To accomplish such a goal, we used methodologies such as RISE [103], SAFA [104–107], or TAPE, where the environmental, social, economic, governance, health, and nutrition dimensions are evaluated [108,109] in order to enhance the existing synergies between producers. It is also essential to identify the hot spots of land use and cover change [110,111], to strengthen sustainable intensification programs with tools such as conservation psychology [112], and to prevent the advance of the livestock frontier.

The classification into quintiles (groups from lower to higher incomes) is an effective tool since it could favor the implementation of policy strategies that are aimed at improving livelihoods, and the implementation of actions to mitigate and adapt to climate change. In this regard, according to Mujica et al. [93] and Luna [94], the use of quintiles facilitated the implementation of development policies to address the inequalities that were caused by COVID-19 in Latin America.

3.2. Inequity in Economic Income

The results of the Gini coefficient (0.52) and the Lorenz curve illustrate the income inequality of small-scale cattle producers in the Ecuadorian Andes. In this area, it is demonstrated that the poorest 20% of the population only obtain 3.40% of the income, while the 20% of the richest quintile obtain around 54% of the total income (Figure 3).

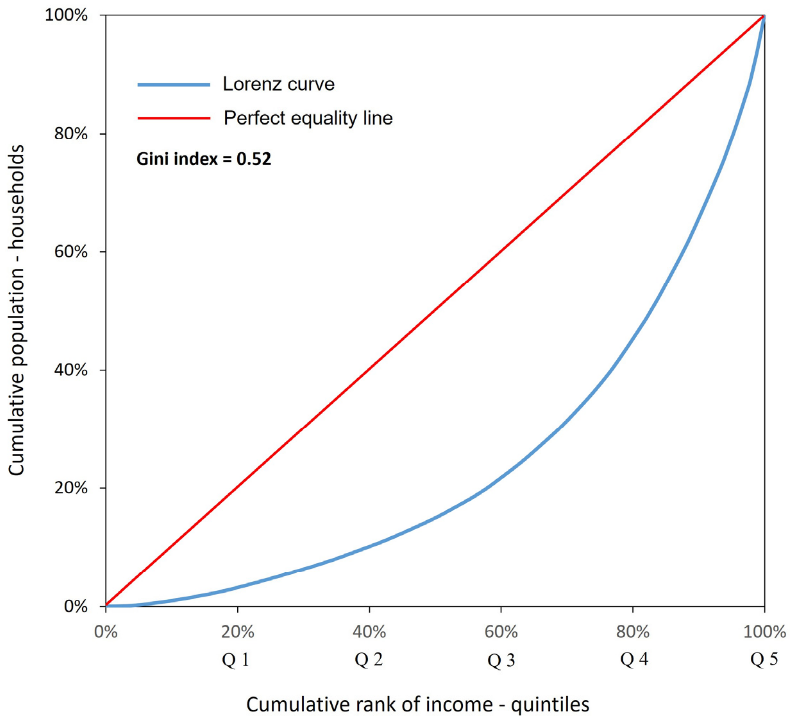

Figure 3. Lorenz curve of income distribution among small-scale dairy farmers in the Ecuadorian Andes.

3.3. Income from Cattle Activity by Quintiles

The average total cattle income was obtained by adding the income from production, the sale of milk, and consumption (milk) on the farm (Table 4). Between the quintiles, there are significant differences. In the first quintile (Q1), an income of USD 1174.26 was obtained; in the second quintile (Q2), USD 3577.99; in the third quintile (Q3), USD 6156.63;

in the fourth quintile (Q4), USD 8711.38; and in the fifth quintile (Q5), USD 14,122.48. Therefore, in the first quintile (Q1), being the poorest, there is a lower average annual income compared to the fifth quintile (Q5), which represents the nonpoor.

Table 4. Means and standard deviations in USD of income from livestock activity by quintiles of small livestock producers in Chimborazo and Tungurahua (2018).

Variables	Q1 <20%	Q2 20–40%	Q3 40–60%	Q4 60–80%	Q5 >80%	Average USD	Significance
	USD	USD	USD	USD	USD		
Average total livestock income	1174.26 (595.98)	3577.99 (624.30)	6156.63 (727.35)	8711.38 (940.03)	14,122.48 (3115.40)	3399.22 (3551.66)	***
Average household size	3.54	3.18	3.47	2.93	3.56	3.42	ns
Average income per capita/daily	0.91	3.08	4.86	8.15	10.87	2.72	***
Poverty category	Extremely poor	Moderately poor	Not so well-off	Moderately well-off	Well-off	Moderately poor	
Sample percentage	58%	18%	11%	8%	5%	100	

Values in parentheses are the standard deviations of the means. *** $p < 0.001$; ns = not significantly different.

In the analysis of the household size, there are no significant differences, while the average number of members per household was determined to range by three to four members, and a general figure between the households of the quintiles, Q1 and Q5. A similar scenario occurs in the Los Sainos microbasin, which is located in the municipality of El Dovio (Colombia), where the livelihood strategy of rural households is the production of cow’s milk, on the basis of grazing [113]. There, it has been stated that the household size is the most important determinant of the investment in labor for household farms, and that it also influences the need to increase milk production for domestic consumption, as well as for the free market [114].

The average income per capita/daily was obtained from the average total income from the cattle divided by the size of the household, and during the whole year. The resulting values present a significant difference between the quintiles, where the daily values were USD 0.91 in the first quintile (Q1), with increases of USD 2.17, USD 3.95, USD 7.24, and USD 9.96, which were distributed between the quintiles, Q1 to Q5, respectively. In the Andes region, it has been identified that the poorest households that are dedicated to milk production serve as assets for investments and sources of savings for household consumption [115]. In rural areas of the departments of Puno and Cajamarca in Peru, cattle ranching has been demonstrated to be an effective strategy to reduce or to escape poverty [116].

Furthermore, the category, according to the INEC [96], that belongs to the surveyed individuals was analyzed, where the first quintile (Q1) corresponds to the category of the extremely poor grouping of the largest number of cattle-raising households, while the second quintile to the fifth quintile were defined as moderately poor (Q2), not so well-off (Q3), moderately well-off (Q4), and well-off (Q5). Finally, the percentage of the sample that corresponds to each quintile was calculated, where, in the first quintile (Q1), it corresponds to 58%; in the second quintile (Q2), to 18%; in the third quintile (Q3), to 11%; in the fourth quintile (Q4), to 8%; and in the fifth quintile (Q1), to only 5%. There is scientific evidence that households that live in extreme poverty have few opportunities for productive work, little access to land that is suitable for agricultural and livestock use, erosion and progressive degradation, and their location in a fragile ecosystem, as represented by the páramo [117]. Consequently, these populations suffer not only from poverty, but also from food insecurity, despite the fact that they apparently have the natural resources that are necessary for their subsistence [118]. Finally, some rural households respond to the income shock by migrating to seek work in nonagricultural sectors [119].

3.4. Characterization of Rural Livelihoods by Quintiles

In the following section, the characterization of rural livelihoods is indicated by using the theory of capitals, which includes the variable of the human, social, natural, financial, and physical capitals in small-scale cattle producers in the given study area of the Ecuadorian Andes.

3.4.1. Human and Social Capital

In relation to the ethnic variable, there are some significant differences. It was identified that out of all of the ranchers that were surveyed in the first quintile (Q1), 78.6% of them were of Kichwa nationality, and the residual 21.4% were Mestizos, while, in the quintiles (Q2), (Q3), and (Q4), there were less Kichwa and more Mestizos, which is in contrast to the fifth quintile (Q5), where all 100% were of Mestizo origin. In general, there were 11.2% more indigenous Kichwa than mestizo milk producers (Table 5). The results reaffirm the theory that social, productive, and labor inequalities will prevent the end of the poverty of indigenous peoples. Additionally, they could cause migration processes of indigenous women and men outside of their traditional territories, which, in some cases, can lead to work in the formal economy [120]. Furthermore, in order to face greater occasional dependency, they work in agriculture, construction, domestic work, or informal commerce [121], where they obtain their livelihoods, which is also the result of the lack of opportunities in the formal economy [122].

Table 5. Averages of the main variables that represent human and social capital in small livestock producers in Chimborazo and Tungurahua, the Ecuadorian Andes.

Variables		Quintiles					Average	Significance
		Q1	Q2	Q3	Q4	Q5		
Ethnicity	Kichwa %	78.6	39.4	15.8	14.3	-	55.6	***
	Mestizo %	21.4	60.6	84.2	85.7	100	44.4	
Gender of household head	Man %	76.7	66.7	52.6	64.3	66.7	70.8	ns
	Women %	23.3	33.3	47.4	35.7	33.3	29.2	
Age of household head	(years)	42.0	45.9	41.9	47.5	36.8	42.9	ns
Education of household head (years)	Basic %	56.3	54.5	57.9	50.0	77.8	56.7	ns
	Medium %	19.4	18.2	21.1	28.6	11.1	19.7	
	College %	5.8	30	5.3	-	11.1	5.1	
	None %	18.4	24.2	15.8	21.4	-	18.5	
Generational Replacement	Yes %	72.8	81.8	89.5	71.4	88.9	77.0	ns
	No %	27.2	18.2	10.5	21.4	11.1	22.5	
Belongs to an association	Yes %	38.8	57.6	78.9	71.4	55.6	50.0	***
	No %	61.2	42.4	21.1	286	44.4	50.0	

*** $p < 0.001$; ns = not significantly different.

In terms of the gender of the head of the household, and referring to all the quintiles evaluated, it was evidenced that men predominate, with 70.8%, which could be a constraint to local holistic development, since it has been proven that rural women (heads of household) play a key role in the promotion of pro-environmental behaviors in rural production [123]. Several investigations have indicated the special bond between women and the environment [120–124]. Early notions of women and the environment are primarily reflected in the ecofeminism theory from the 1980s, which suggests that women are especially "close to nature" in a spiritual or conceptual sense [125]. Furthermore, some scholars suggest that women are imbued with a stronger ethical approach to environmental survival, which is fundamentally different from that of men [126]. Consequently, women are more likely to protect natural resources for the continued survival of their families [127].

With regard to the age of the head of household, it was determined that in the first quintile (Q1) and the third quintile (Q3), there is an average age of 42 years, and the fifth quintile (Q5) reveals a younger age (37 years), while the fourth quintile (Q4) yields a higher age (48 years), among the groups that were evaluated. The average age of the heads of households is about 43 years. In terms of the education of the heads of households (that is, the degree of educational instruction that he has received), we encountered that from the first quintile (Q1) to the fifth quintile (Q5), the majority of household heads have basic education, followed by secondary education, and the third level is the denomination of "none" (that is, they have no level of study). It is determined that the level of study or the educational system is extremely limited in its powers to reduce poverty and to increase intergenerational social mobility [128]. The standard policy formula—expanding access to education, increasing social mobility, and reducing poverty—does not stand up to close scrutiny, and it may have unintended consequences that serve to undermine the stated purpose of educational reform. This does not mean that education is a wasted investment [129], or that it is simply an institutional instrument for social reproduction [130]. However, it does mean that education must be studied as an integral part of a more holistic and contextual theory that recognizes educational reform as a "complementary condition" [131] for increasing social justice and individual well-being.

On the other hand, among the determined quintiles, there is a difference of 54.5% of milk producers who have a replacement generation, which indicates that more than half of the ranchers will have continuity with the agro-livestock practices of the area. In addition, in terms of the associativity, there are significant differences between the quintiles, where it is evident that 50% between the quintiles belong to an association. Several studies have indicated that belonging to productive associations has been effective at alleviating rural poverty [132]. To date, extensive research has identified the different mechanisms through which the associations are able to contribute to poverty alleviation for farmers. For example, associations can increase the efficiency and productivity of on-farm processes through the acquisition of shared inputs and machinery [133,134], which can improve the bargaining power of farmers and facilitate their access to broader markets [133,135–137]. They can also link farmers with supply-chain actors and mitigate gender issues [138–140], and they are able to support knowledge building, as well as the creation of social capital at the local level [141].

3.4.2. Natural Capital

There is a significant difference between the groups of producers from Q1 to Q5 of 4.63 ha and 4.18 ha in the farm area and the pasture area, respectively (Table 6). Similar scenarios with regard to the livestock production in the highlands of Peru are largely based on pasture grazing, which is supplemented with crop residues, and particularly stubble, or agricultural byproducts and, in certain cases, with improved foraging resources. Thus, grasslands, with native grass species constitute the main food resource of mixed farming systems with ruminant species [142]. Small-scale pastoralist dairy farming in Zambia plays an important role in poverty reduction, employment opportunities, wealth creation, and household food, as well as in nutrition security [143].

Table 6. Means and standard deviations of the main variables that represent natural capital in small livestock producers in Chimborazo and Tungurahua in 2018.

Variables	Quintiles					Average	Significance
	Q1	Q2	Q3	Q4	Q5		
Total farm area (ha)	2.37 (2.12)	2.79 (1.99)	3.08 (1.65)	3.82 (1.49)	7.00 (5.07)	2.87 (2.45)	***
Pasture area (ha)	1.60 (1.52)	2.45 (1.65)	2.63 (1.38)	3.68 (1.51)	5.78 (2.99)	2.24 (1.91)	***
Cultivation area (ha)	0.77 (1.08)	0.33 (0.77)	0.45 (0.52)	0.14 (0.36)	1.22 (2.64)	0.63 (1.09)	ns

Values in parentheses are the standard deviations of the means. *** $p < 0.001$; ns = not significantly different.

3.4.3. Physical and Financial Capital

There are substantial differences in the "total cows" variable in the per capita production, where the values ranged from 2 in Q1 to 8 in Q5, which is a similar scenario as in Kilosa, Tanzania, where cattle contribute heavily to household livelihoods and food security, but fodder scarcity is a limiting factor [144]. In addition, it was identified that the producers in Q1 use 14.3% more water than the producers in Q5, and that only the producers that belong to Q3 have cement as the floor for milking. With regard to who performs the milking, it was identified that women predominate in this activity, and that they do not receive any economic bonuses at all, in all of the quintiles (Table 7).

Table 7. Averages of the main variables that represent physical and financial capital in small livestock producers in Chimborazo and Tungurahua in 2018.

Variables		Quintiles					Average	Significance
		Q1	Q2	Q3	Q4	Q5		
Total cows in production per household	Cow unit	1.93	3.12	4.11	4.93	8.44	2.95	***
Milking water	*Yes %*	69.9	81.8	78.9	42.1	55.6	70.2	
	No %	30.1	18.2	21.1	57.9	44.4	29.8	
Milking-floor type	*Earth %*	97.1	100	84.2	100	100	96.3	ns
	Cement %	-	-	10.5	-	-	2.1	
	Lack of %	2.9	-	5.3	-	-	1.6	
Milk container	*AI drums %*	11.7	27.3	26.3	50.0	33.3	20.2	ns
	Aluminum drums %	64.1	60.6	68.4	14.3	44.4	59.0	
	Plastic tanks %	9.7	3.0	5.3	35.7	11.1	10.1	
	Others	14.6	9.1	-	-	11.1	10.7	
Who realizes the milking	*Man %*	21.4	9.1	15.8	14.3	-	16.9	ns
	Women %	73.8	87.9	73.7	85.7	100	78.7	
	Both %	4.9	3.0	10.5	-	-	4.5	
Receives bonus	*Yes %*	41.7	30.3	26.3	28.6	11.1	35.4	ns
	No%	58.3	69.7	73.7	71.4	88.9	64.6	

*** $p < 0.001$; ns = not significantly different.

3.5. Perception of Climate Change and Readiness to Accept Adaptation as Well as Mitigation Measures

With regard to the variables of the perception of climate change, there is evidence of heterogeneity in the responses (Table 8). It is fundamental to consider that the perception of climate change is a complex process that encompasses a variety of psychological constructs, such as the knowledge, beliefs, attitudes, and concerns about whether and how the climate is changing [145]. Perception is influenced and shaped by, among other things, the characteristics of individuals, their experiences, the information they receive, and the cultural and geographic contexts in which they live [145,146]. Therefore, measuring the perception of climate change, and trying to find its determinants, is a rather complex task.

Table 8. Averages of the main variables related to climate change and willingness to accept mitigation and adaptation actions in small livestock producers in Chimborazo and Tungurahua, 2018.

Variables		Quintiles					Average	Significance
		Q1	Q2	Q3	Q4	Q5		
Understanding about climate change.	*Yes %*	27.2	25.0	31.6	42.9	44.4	29.4	ns
	No %	70.9	68.8	68.4	50.0	55.6	67.8	
	Some %	1.9	6.2	-	7.1	-	2.8	
Does the weather change in your area?	*Yes, a lot %*	26.2	33.3	31.6	64.3	55.6	32.6	ns
	Yes, a little %	44.7	27.3	42.1	7.1	33.3	37.6	
	No %	9.7	15.2	15.8	-	-	10.1	
	Unsure %	19.4	24.2	10.5	28.6	1.1	19.7	
Willingness to receive climate-change training.	*Yes %*	81.6	84.8	78.9	100	100	84.3	ns
	No %	18.4	15.2	21.1	-	-	15.7	
Willingness to adopt appropriate cattle-management practices.	*Yes %*	80.6	66.7	47.4	42.9	44.4	69.7	ns
	No %	19.4	33.3	52.6	57.1	55.6	30.3	
Access to climatological information.	*Yes %*	10.7	15.2	15.8	28.6	22.2	14.0	ns
	No %	89.3	84.8	84.2	71.4	77.8	86.0	
In the last ten years, have you adopted adaptive actions to climate change?	*Yes %*	5.8	12.1	-	14.3	11.1	7.3	ns
	No %	94.2	87.9	100	85.7	88.9	92.7	
Willingness to invest labor and materials to adopt actions adapting to climate change.	*Yes %*	84.5	84.8	57.9	64.3	66.7	79.2	***
	No %	15.5	15.2	42.1	35.7	33.3	20.8	

*** $p < 0.001$; ns = not significantly different.

The producers of Q1 are those who least understand climate change, in general terms, while, in most of the quintiles that were evaluated, they do not understand climate change. This is worrying since it has been revealed that knowledge about climate change is a critical determinant of the behavior of rural producers, especially in order to achieve adaptation strategies [147,148]. In addition, in the Ecuadorian Andes, there is a lack of thinking in terms of planning in the face of the existing and future scenarios of climate change [149–151], considering that the increase in temperatures, the retreat of glaciers, and changes in the frequency and intensity of precipitation and frost have been documented in the Andean highlands over the past thirty years [152–156], which has coincided with greater uncertainty and the exposure to multiple climatic stresses in the northern highlands of Bolivia [157]. This coincides with the results of a changing climate in the study area, where the producers from Q1 to Q5 responded more frequently to the option "Yes a little".

Adapting to climate change requires a change in people's behavior, knowledge, and abilities in order to help build their resilience. Typically, such learning is facilitated through informal and formal institutions [158]. It has been demonstrated that rural farmers in the Peruvian Andes achieved significantly greater knowledge of integrated pest-management practices in the face of a changing climate than those in the comparison group of nonparticipants, and, consequently, significantly improved field productivity [159], in such a way that similar results would be expected with the producers belonging to Q1 to Q5. This occurs since most of them are willing to receive training on climate change. As a consequence, there would be an increase in the awareness about the best local adaptations available that can be used to manage climate risks [160], while, at the same time, this would allow for the avoidance of maladaptation under a changing climate and, thus, of rebound vulnerability, shifting vulnerability, and the erosion of sustainable development [161,162].

The management of good livestock practices leads to optimal productivity results, which increases the profits of the livestock producer and improves the quality of life of the peasant family under a changing climate [163]. This is presented as an optimal scenario for producers who expect to conduct good livestock practices to face climate change (Table 7). There is a total average of 30% who are distributed among the quintiles of poverty, and who lack the desire to perform good livestock practices, which may be related to the low levels of education of the population studied and the age of the head of the household (Table 4).

Among climate-smart approaches, climate information services (CIS) remain a credible option to increase productivity and to avoid losses in the agricultural and livestock sectors [164]. CIS refers to the production, translation, transfer, and use of scientific information for decision making [165,166]. It was identified that the access to and use of climate information helped Senegalese producers to formulate tactical decisions before, during, and after the agricultural and livestock management seasons [167]. Therefore, it is essential to provide CIS to the assessed farmers, as 86% of the producers among the quintiles lacked access to climate information, and as there is no significant difference between the producers from Q1 to Q5. Therefore, the same adoption strategy may be considered.

In the variable "willingness to invest labor and materials to adopt actions adapting to climate change", there is a significant difference between the quintiles, despite the fact that most answered affirmatively, with an average value of 79.2%. In this respect, farmers are willing to invest in household labor and farm materials in order to follow adaptation and mitigation actions if they receive support and training in this matter. These findings are important for the design of local adaptation and mitigation actions, such as those conducted in the Chilean and northern Ecuadorian Andes [168–170].

4. Conclusions

The quintiles were determined on the basis of the total income of the livestock activity of a sample of 178, being the total number of the surveyed households, where there are 103 households in the first quintile (Q1), which represents 58%; 33 households representing 18% in the second quintile; 19 households representing 11% in the third quintile (Q3); 14 households representing 8% in the fourth quintile (Q4); and 9 households representing 5% in the fifth quintile (Q5).

Through an analysis by quintiles, it was determined that the households that are part of Q1 are most of the inhabitants in the entire sample (58%), who obtain an average per capita/daily income of USD 0.91. Therefore, they are the households that are categorized in "extreme poverty" by the Ecuadorian INEC. In this category, the largest number are of the Kichwa ethnic group (78%), where 61% of these families do not belong to any association of producers. In addition, 70% of these households mentioned a lack of any knowledge about climate change.

In Q5, they are the most economically well-off, earning an average of USD 14,122.48 per year, which represents an average per capita/daily income of USD 10.87. Therefore, they are the households that are categorized as "well-off". However, only 5% of the households in the entire sample fall into this category.

With regard to climate change, in the entire study area, only 29% of the population were aware of climate change, while Q4 and Q5 included the ones who understand climate change the most, and those who have realized that the climate is changing. The entire number of households in this quintile were willing to receive training on climate change. About 70% of the entire population of the study area was willing to adopt appropriate cattle-management actions that are adapted to the climate, and around 80% are willing to invest labor and materials from the farm to implement adaptation and mitigation actions if they receive support and training on climate change. Finally, the study suggests that the quintile classification in groups that ranges from lower to higher incomes favors a more effective implementation of development policies at the local level in high-poverty areas that are located in fragile ecosystems.

Author Contributions: Conceptualization, B.T., J.C. and E.T.; methodology, B.T., M.L. and E.T.; investigation, B.T., S.P., K.A. and M.L.; writing—original draft preparation, B.T., S.P., K.A., M.H.-R. and T.T.; writing—review and editing, B.T., J.C., M.H.-R., T.T. and A.G. All authors have read and agreed to the published version of the manuscript.

Funding: This the authors received no financial support for the research, authorship, and/or publication of this article.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of Pontificia Universidad Católica del Ecuador Sede Ibarra, on 4 April 2019).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: This is not applicable as the data are not in any data repository of public access, however if editorial committee needs access, we will happily provide them, please use this email: btorres@uea.edu.ec.

Acknowledgments: The authors would like to thank Universidad Estatal Amazónica (UEA) for their support during the desk research of the main author. We also thank the families of the study area who shared valuable information about their livestock activities.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Ansoms, A.; McKay, A. A quantitative analysis of poverty and livelihood profiles: The case of rural Rwanda. *Food Policy* **2010**, *35*, 584–598. https://doi.org/10.1016/j.foodpol.2010.06.006.
2. Mutenje, M.; Ortmann, G.; Ferrer, S.; Darroch, M. Rural livelihood diversity to manage economic shocks: Evidence from south-east Zimbabwe. *Agrekon* **2010**, *49*, 338–357. https://doi.org/10.1080/03031853.2010.503381.
3. Ellis, F. The Determinants of Rural Livelihood Diversification in Developing Countries. *J. Agric. Econ.* **2008**, *51*, 289–302. https://doi.org/10.1111/j.1477-9552.2000.tb01229.x.
4. Scoones, I. *Sustainable Rural Livelihoods: A Framework for Analysis*; IDS: Brighton, UK, 1998.
5. Kibria, A.M.G.; Jashimuddin, M.; Makoto, I. Effects of participatory forest management on livelihood capitals of the community in Cox's Bazar, Bangladesh. *J. For. Res.* **2014**, *19*, 42–51.
6. Angelsen, A.; Jagger, P.; Babigumira, R.; Belcher, B.; Hogarth, N.J.; Bauch, S.; Börner, J.; Smith-Hall, C.; Wunder, S. Environmental Income and Rural Livelihoods: A Global-Comparative Analysis. *World Dev.* **2014**, *64* (Suppl. 1), S12–S28. https://doi.org/10.1016/j.worlddev.2014.03.006.
7. Berg, M.V.D. Household income strategies and natural disasters: Dynamic livelihoods in rural Nicaragua. *Ecol. Econ.* **2010**, *69*, 592–602. https://doi.org/10.1016/j.ecolecon.2009.09.006.
8. Walelign, S.Z.; Pouliot, M.; Larsen, H.O.; Smith-Hall, C. Combining Household Income and Asset Data to Identify Livelihood Strategies and Their Dynamics. *J. Dev. Stud.* **2016**, *53*, 769–787. https://doi.org/10.1080/00220388.2016.1199856.
9. Walelign, S.Z. Getting stuck, falling behind or moving forward: Rural livelihood movements and persistence in Nepal. *Land Use Policy* **2017**, *65*, 294–307. https://doi.org/10.1016/j.landusepol.2017.04.017.
10. Reardon, T.; Taylor, J.E.; Stamoulis, K.; Lanjouw, P.; Balisacan, A. Effects of Non-Farm Employment on Rural Income Inequality in Developing Countries: An Investment Perspective. *J. Agric. Econ.* **2008**, *51*, 266–288. https://doi.org/10.1111/j.1477-9552.2000.tb01228.x.

11. Shackleton, C.M.; Shackleton, S.E.; Buiten, E.; Bird, N. The importance of dry woodlands and forests in rural live-lihoods and poverty alleviation in South Africa. *For. Policy Econ.* **2007**, *9*, 558–577.
12. Alary, V.; Corniaux, C.; Gautier, D. Livestock's Contribution to Poverty Alleviation: How to Measure It? *World Dev.* **2011**, *39*, 1638–1648. https://doi.org/10.1016/j.worlddev.2011.02.008.
13. Christiaensen, L.J.; Demery, L.; Khl, J. *The Role of Agriculture in Poverty Reduction: An Empirical Perspective*; World Bank Publications: Washington, DC, USA, 2006; Volume 4013.
14. Hogarth, N.; Belcher, B.; Campbell, B.; Stacey, N. The Role of Forest-Related Income in Household Economies and Rural Livelihoods in the Border-Region of Southern China. *World Dev.* **2012**, *43*, 111–123. https://doi.org/10.1016/j.worlddev.2012.10.010.
15. Soltani, A.; Angelsen, A.; Eid, T.; Naieni, M.S.N.; Shamekhi, T. Poverty, sustainability, and household livelihood strategies in Zagros, Iran. *Ecol. Econ.* **2012**, *79*, 60–70. https://doi.org/10.1016/j.ecolecon.2012.04.019.
16. Torres, B.; Vasco, C.; Günter, S.; Knoke, T. Determinants of Agricultural Diversification in a Hotspot Area: Evidence from Colonist and Indigenous Communities in the Sumaco Biosphere Reserve, Ecuadorian Amazon. *Sustainability* **2018**, *10*, 1432. https://doi.org/10.3390/su10051432.
17. Torres, B.; Günter, S.; Acevedo-Cabra, R.; Knoke, T. Livelihood strategies, ethnicity and rural income: The case of migrant settlers and indigenous populations in the Ecuadorian Amazon. *For. Policy Econ.* **2018**, *86*, 22–34. https://doi.org/10.1016/j.forpol.2017.10.011.
18. Torres, B.; Eche, D.; Torres, Y.; Bravo, C.; Velasco, C.; García, A. Identification and Assessment of Livestock Best Management Practices (BMPs) Using the REDD+ Approach in the Ecuadorian Amazon. *Agronomy* **2021**, *11*, 1336. https://doi.org/10.3390/agronomy11071336.
19. Fang, Y.; Qin, D.; Ding, Y. Frozen soil change and adaptation of animal husbandry: A case of the source regions of Yangtze and Yellow Rivers. *Environ. Sci. Policy* **2011**, *14*, 555–568. https://doi.org/10.1016/j.envsci.2011.03.012.
20. Fang, Y.-P. The effects of natural capital protection on pastoralist's livelihood and management implication in the source region of the Yellow River, China. *J. Mt. Sci.* **2013**, *10*, 885–897. https://doi.org/10.1007/s11629-013-2422-1.
21. Gentle, P.; Maraseni, T.N. Climate change, poverty and livelihoods: Adaptation practices by rural mountain communities in Nepal. *Environ. Sci. Policy* **2012**, *21*, 24–34. https://doi.org/10.1016/j.envsci.2012.03.007.
22. Beverly, S.G. Measures of material hardship: Rationale and recommendations. *J. Poverty* **2001**, *5*, 23–41.
23. Hallegatte, S.; Fay, M.; Barbier, E.B. Poverty and climate change: Introduction. *Environ. Dev. Econ.* **2018**, *23*, 217–233. https://doi.org/10.1017/s1355770x18000141.
24. Anand, S.; Harris, C.J. Choosing a welfare indicator. *Am. Econ. Rev.* **1994**, *84*, 226–231.
25. Guo, Y.; Zhou, Y.; Liu, Y. Targeted poverty alleviation and its practices in rural China: A case study of Fuping county, Hebei Province. *J. Rural Stud.* **2019**, *2*, 10. https://doi.org/10.1016/j.jrurstud.2019.01.007.
26. Liu, Y.; Liu, J.; Zhou, Y. Spatio-temporal patterns of rural poverty in China and targeted poverty alleviation strategies. *J. Rural Stud.* **2017**, *52*, 66–75. https://doi.org/10.1016/j.jrurstud.2017.04.002.
27. Foster, J.E. Absolute versus Relative Poverty. *Am. Econ. Rev.* **1998**, *88*, 335–341.
28. Chen, S.; Ravallion, M. Absolute poverty measures for the developing world, 1981–2004. *Proc. Natl. Acad. Sci. USA* **2007**, *104*, 16757–16762. https://doi.org/10.1073/pnas.0702930104.
29. Hulme, D.; Shepherd, A. Conceptualizing Chronic Poverty. *World Dev.* **2003**, *31*, 403–423. https://doi.org/10.1016/s0305-750x(02)00222-x.
30. Ward, P.S. Transient Poverty, Poverty Dynamics, and Vulnerability to Poverty: An Empirical Analysis Using a Balanced Panel from Rural China. *World Dev.* **2015**, *78*, 541–553. https://doi.org/10.1016/j.worlddev.2015.10.022.
31. Powell, M.; Boyne, G.; Ashworth, R. Towards a geography of people poverty and place poverty. *Policy Politics* **2001**, *29*, 243–258. https://doi.org/10.1332/0305573012501332.
32. Park, A.; Wang, S.; Wu, G. Regional poverty targeting in China. *J. Public Econ.* **2002**, *86*, 123–153. https://doi.org/10.1016/s0047-2727(01)00108-6.
33. Bourguignon, F.; Chakravarty, S.R. The measurement of multidimensional poverty. In *Poverty, Social Exclusion and Stochastic Dominance*; Springer: Singapore, 2019; pp. 83–107.
34. Milbourne, P. The Geographies of Poverty and Welfare. *Geogr. Compass* **2010**, *4*, 158–171. https://doi.org/10.1111/j.1749-8198.2009.00296.x.
35. Li, Q.; Sun, P.; Li, B.; Mohiuddin, M. Impact of Climate Change on Rural Poverty Vulnerability from an Income Source Perspective: A Study Based on CHIPS2013 and County-Level Temperature Data in China. *Int. J. Environ. Res. Public Health* **2022**, *19*, 3328. https://doi.org/10.3390/ijerph19063328.
36. Amato, P.R.; Zuo, J. Rural poverty, urban poverty, and psychological well-being. *Sociol. Q.* **1992**, *33*, 229–240.
37. Du, Y.; Park, A.; Wang, S. Migration and rural poverty in China. *J. Comp. Econ.* **2005**, *33*, 688–709. https://doi.org/10.1016/j.jce.2005.09.001.
38. Liu, Y.; Xu, Y. A geographic identification of multidimensional poverty in rural China under the framework of sustainable livelihoods analysis. *Appl. Geogr.* **2016**, *73*, 62–76. https://doi.org/10.1016/j.apgeog.2016.06.004.
39. Ding, J.; Leng, Z.M. Regional poverty analysis in a view of geography science. *Acta Geogr. Sin.* **2018**, *73*, 232–247.
40. Zhou, Y.; Guo, Y.; Liu, Y.; Wu, W.; Li, Y. Targeted poverty alleviation and land policy innovation: Some practice and policy implications from China. *Land Use Policy* **2018**, *74*, 53–65. https://doi.org/10.1016/j.landusepol.2017.04.037.

41. Zhou, Y.; Guo, L.; Liu, Y. Land consolidation boosting poverty alleviation in China: Theory and practice. *Land Use Policy* **2018**, *82*, 339–348. https://doi.org/10.1016/j.landusepol.2018.12.024.
42. World Bank. Poverty and Shared Prosperity. In *Reversals of Fortune*; World Bank: Washington, DC, USA, 2020. https://doi.org/10.1596/978-1-4648-1602-4.
43. *Strategic Work of FAO to Reduce Rural Poverty*; FAO: Roma, Italy, 2017.
44. Zhang, H.; Wang, Z.; Liu, J.; Chai, J.; Wei, C. Selection of targeted poverty alleviation policies from the perspective of land resources-environmental carrying capacity. *J. Rural Stud.* **2019**. https://doi.org/10.1016/j.jrurstud.2019.02.011.
45. UN 2015 UN General Assembly Resolution Adopted by the General Assembly on 25 September 2015. http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E (accessed on 6 January 2022).
46. Griggs, D.; Stafford-Smith, M.; Gaffney, O.; Rockström, J.; Öhman, M.C.; Shyamsundar, P.; Noble, I. Sustainable development goals for people and planet. *Nature* **2013**, *495*, 305–307.
47. Zhou, Y.; Liu, Y. The geography of poverty: Review and research prospects. *J. Rural Stud.* **2019**. https://doi.org/10.1016/j.jrurstud.2019.01.008.
48. Fan, S.; Brzeska, J.; Keyzer, M.; Halsema, A. From subsistence to profit: Transforming smallholder farms. *Intl. Food Policy Res. Inst*. **2013**, *26*. http://dx.doi.org/10.2499/9780896295582.
49. Grubbström, A.; Sooväli-Sepping, H. Estonian family farms in transition: A study of intangible assets and gender issues in generational succession. *J. Hist. Geogr.* **2012**, *38*, 329–339. https://doi.org/10.1016/j.jhg.2012.03.001.
50. Wegren, S.K.; O'Brien, D.J. Introduction to symposium: Smallholders in communist and postcommunist societies. *J. Agrar. Chang.* **2018**, *18*, 869–881. https://doi.org/10.1111/joac.12281.
51. Alkire, S.; Roche, J.M.; Ballon, P.; Foster, J.; Santos, M.E.; Seth, S. *Multidimensional Poverty Measurement and Analysis*; Oxford University Press: Oxford, UK, 2015.
52. Carney, D.; Drinkwater, M.; Rusinow, T.; Neefjes, K.; Wanmali, S.; Singh, N. *Livelihoods Approaches Compared—A Brief Comparison of the Livelihoods Approaches of the UK Department for International Development (DFID), CARE*; Oxfam and the United Nations Development Programme (UNDP) UK Department for International Development: New York, NY, USA, 1999.
53. Onyekwere, I.; Nworgu, K.O. Amenazas a los medios de vida rurales en Nigeria: Implicaciones para el orden social y la gestión de crisis. *Av. En Sociol. Apl.* **2020**, *10*, 41.
54. Gasper, D. Securing Humanity: Situating 'Human Security' as Concept and Discourse. *J. Hum. Dev.* **2005**, *6*, 221–245. https://doi.org/10.1080/14649880500120558.
55. Bigman, D.; Fofack, H. Geographical Targeting for Poverty Alleviation: An Introduction to the Special Issue. *World Bank Econ. Rev.* **2000**, *14*, 129–145. https://doi.org/10.1093/wber/14.1.129.
56. Do, Q.-T.; Iyer, L. Geography, poverty and conflict in Nepal. *J. Peace Res.* **2010**, *47*, 735–748. https://doi.org/10.1177/0022343310386175.
57. Luo, Q.; Xj, L. Progress in the study of rural poverty geography in foreign countries. *Econ. Geogr.* **2014**, *34*, 1–8.
58. Scherr, S.J. A downward spiral? Research evidence on the relationship between poverty and natural resource deg-radation. *Food Policy* **2000**, *25*, 479–498.
59. Cavendish, W. Empirical Regularities in the Poverty-Environment Relationship of Rural Households: Evidence from Zimbabwe. *World Dev.* **2000**, *28*, 1979–2003. https://doi.org/10.1016/s0305-750x(00)00066-8.
60. Gray, L.C.; Moseley, W.G. A geographical perspective on poverty-environment interactions. *Geogr. J.* **2005**, *171*, 9–23. https://doi.org/10.1111/j.1475-4959.2005.00146.x.
61. Dasgupta, S.; Deichmann, U.; Meisner, C.; Wheeler, D. Where is the poverty–environment nexus? Evidence from Cambodia, Lao PDR, and Vietnam. *World Dev.* **2005**, *33*, 617–638.
62. Lufumpa, C.L. The Poverty-Environment Nexus in Africa. *Afr. Dev. Rev.* **2005**, *17*, 366–381. https://doi.org/10.1111/j.1017-6772.2006.00120.x.
63. Cao, S.; Zhong, B.; Yue, H.; Zeng, H.; Zeng, J. Development and testing of a sustainable environmental restoration policy on eradicating the poverty trap in China's Changting County. *Proc. Natl. Acad. Sci. USA* **2009**, *106*, 10712–10716.
64. Barbier, E.B. The challenges for environment and development economics. *Environ. Dev. Econ.* **2014**, *19*, 287–290. https://doi.org/10.1017/s1355770x14000175.
65. Casillas, C.E.; Kammen, D.M.; Matyas, F.; Sreenivasan, V.; Marbach, F.; Wacongne, C.; Barsy, B.; Mateo, C.; Aronoff, R.; Petersen, C.C.H. The Energy-Poverty-Climate Nexus. *Science* **2010**, *330*, 1181–1182. https://doi.org/10.1126/science.1197412.
66. Watmough, G.; Atkinson, P.M.; Saikia, A.; Hutton, C. Understanding the Evidence Base for Poverty–Environment Relationships using Remotely Sensed Satellite Data: An Example from Assam, India. *World Dev.* **2016**, *78*, 188–203. https://doi.org/10.1016/j.worlddev.2015.10.031.
67. Bird, K.; Shepherd, A. Livelihoods and Chronic Poverty in Semi-Arid Zimbabwe. *World Dev.* **2003**, *31*, 591–610. https://doi.org/10.1016/s0305-750x(02)00220-6.
68. Partridge, M.D.; Rickman, D.S. Distance from urban agglomeration economies and rural poverty. *J. Reg. Sci.* **2008**, *48*, 285–310. https://doi.org/10.1111/j.1467-9787.2008.00552.x.
69. Tian, F.; Wu, B.; Zeng, H.; Watmough, G.R.; Zhang, M.; Li, Y. Detecting the linkage between arable land use and poverty using machine learning methods at global perspective. *Geogr. Sustain.* **2022**, *3*, 7–20.
70. Henninger, N.; Snel, M. *Where are the Poor? Experiences with the Development and Use of Poverty Maps*; World Resources Institute and UNEP/GRID-Arendal: Washington, DC, USA, 2002.

71. Okwi, P.O.; Ndeng'e, G.; Kristjanson, P.; Arunga, M.; Notenbaert, A.; Omolo, A.; Owuor, J. Spatial determinants of poverty in rural Kenya. *Proc. Natl. Acad. Sci. USA* **2007**, *104*, 16769–16774.
72. Cheng, X.; Shuai, C.M.; Wang, J.; Li, W.J.; Shuai, J.; Liu, Y. Building a sustainable development model for China's poverty-stricken reservoir regions based on system dynamics. *J. Clean. Prod.* **2018**, *176*, 535–554.
73. Zhou, L.; Xiong, L.-Y. Natural topographic controls on the spatial distribution of poverty-stricken counties in China. *Appl. Geogr.* **2017**, *90*, 282–292. https://doi.org/10.1016/j.apgeog.2017.10.006.
74. Ma, Z.; Chen, X.; Chen, H. Multi-scale Spatial Patterns and Influencing Factors of Rural Poverty: A Case Study in the Liupan Mountain Region, Gansu Province, China. *Chin. Geogr. Sci.* **2018**, *28*, 296–312. https://doi.org/10.1007/s11769-018-0943-9.
75. Hertel, T.W.; Rosch, S.D. Climate change, agriculture, and poverty. *Appl. Econ. Perspect. Policy* **2010**, *32*, 355–385.
76. Shimada, G. The impact of climate-change-related disasters on africa's economic growth, agriculture, and conflicts: Can humanitarian aid and food assistance offset the damage? *Int. J. Environ. Res. Public Health* **2022**, *19*, 467.
77. Hallegatte, S.; Vogt-Schilb, A.; Bangalore, M.; Rozenberg, J. *Unbreakable: Building the Resilience of the Poor in the Face of Natural Disasters*; World Bank: Washington, DC, USA, 2016.
78. Hallegatte, S. An Exploration of the Link between Development, Economic Growth, and Natural Risk. *SSRN Electron. J.* **2012**. doi:10.2139/ssrn.2251156.
79. Rozenberg, J.; Hallegatte, S. Model and Methods for Estimating the Number of People Living in Extreme Poverty Because of the Direct Impacts of Natural Disasters. In *World Bank Policy Research Working Paper*; World Bank: Washington, DC, USA, 2016. https://doi.org/10.1596/1813-9450-7887.
80. Datt, G.; Hoogeveen, H. El Niño or El Peso? Crisis, Poverty and Income Distribution in the Philippines. *World Dev.* **2003**, *31*, 1103–1124. https://doi.org/10.1016/s0305-750x(03)00060-3.
81. Rodriguez-Oreggia, E.; De La Fuente, A.; De La Torre, R.; Moreno, H.A. Natural Disasters, Human Development and Poverty at the Municipal Level in Mexico. *J. Dev. Stud.* **2013**, *49*, 442–455. https://doi.org/10.1080/00220388.2012.700398.
82. Akter, S.; Mallick, B. The poverty–vulnerability–resilience nexus: Evidence from Bangladesh. *Ecol. Econ.* **2013**, *96*, 114–124.
83. Rodriguez, F.; Toulkeridis, T.; Padilla, O.; Mato, F. Economic risk assessment of Cotopaxi volcano Ecuador in case of a future lahar emplacement. *Nat. Hazards* **2017**, *85*, 605–618.
84. Echegaray-Aveiga, R.C.; Rodríguez, F.; Toulkeridis, T.; Echegaray-Aveiga, R.D. Effects of potential lahars of the Cotopaxi volcano on housing market prices. *J. Appl. Volcanol.* **2020**, *9*, 1–11.
85. Shepherd, A.; Mitchell, T.; Lewis, K.; Lenhardt, A.; Jones, L.; Scott, L.; Muir-Wood, R. *The Geography of Poverty, Disasters and Climate Extremes in 2030;* ODI: London, UK, 2013; p. 72.
86. MAE. *Sistema de Clasificación de los Ecosistemas del Ecuador Continental*; Subsecretaría de Patrimonio Natural, Ministerio del Ambiente del Ecuador: Quito, Ecuador, 2013.
87. Zambrano, R.; López, M. Breve historia y perspectivas para el futuro del Sistema Nacional de Áreas Protegidas del Ecuador (SNAP). *Memorias* **2015**, *4*, 42.
88. MAG. *Decreto de Creación de la Reserva de Producción de Fauna Chimborazo N°437*; Ministerio de Agricultura y Ganadería: Quito, Ecuador, 1987.
89. Lilliefors, H.W. On the Kolmogorov-Smirnov test for normality with mean and variance unknown. *J. Am. Stat. Assoc.* **1967**, *62*, 399–402.
90. Steinskog, D.J.; Tjøstheim, D.B.; Kvamstø, N.G. A Cautionary Note on the Use of the Kolmogorov–Smirnov Test for Normality. *Mon. Weather Rev.* **2007**, *135*, 1151–1157. https://doi.org/10.1175/mwr3326.1.
91. Lim, T.-S.; Loh, W.-Y. A comparison of tests of equality of variances. *Comput. Stat. Data Anal.* **1996**, *22*, 287–301. https://doi.org/10.1016/0167-9473(95)00054-2.
92. Kim, H.-Y. Analysis of variance (ANOVA) comparing means of more than two groups. *Restor. Dent. Endod.* **2014**, *39*, 74–77. https://doi.org/10.5395/rde.2014.39.1.74.
93. Mujica, O.; Moreno, C. *Guía Ilustrada Paso-a-paso para el Cálculo y Análisis de Desigualdades Ecosociales en Salud*; Organización Panamericana de la Salud: Washington, DC, USA, 2020.
94. Luna, V.M.I. Incremento de la desigualdad mundial y la situación de américa latina de 1962 a 2019. *Vances En Investig. Científica* **2020**, *3*, 853.
95. Reddy, A.A. Disparities in employment and income in rural Andhra Pradesh, India. *Bangladesh Dev. Stud.* **2011**, *34*, 73–96.
96. INEC. *Reporte de pobreza y desigualdad 2018*; Instituto Nacional de Estadísticas y Censos: Quito, Ecuador, 2018; p. 9.
97. Bishop, J.A.; Formby, J.P.; Thistle, P.D. Changing American earnings distributions: One-half century of experience. *Empir. Econ.* **1997**, *22*, 501–514. https://doi.org/10.1007/bf01205776.
98. Atkinson, A. Measurement of inequality. *J. Econ. Theory* **1970**, *1*, 244–263.
99. Paredes, R.P.; Escobar, F. El rol de la ganadería y la pobreza en el área rural de Puno. *Rev. De Investig. Altoandinas* **2018**, *20*, 39–60.
100. Holden, S.T.; Shiferaw, B.; Pender, J. Non-farm income, household welfare, and sustainable land management in a less-favoured area in the Ethiopian highlands. *Food Policy* **2004**, *29*, 369–392. https://doi.org/10.1016/j.foodpol.2004.07.007.
101. John, C. *The Dynamics of Inequality and Poverty: Comparing Income Distributions;* Edward Elgar Publishing: Boston, MA, USA, 1998.

102. Shackleton, S.; Campbell, B.; Lotz-Sisitka, H.; Shackleton, C. Links between the Local Trade in Natural Products, Livelihoods and Poverty Alleviation in a Semi-arid Region of South Africa. *World Dev.* **2008**, *36*, 505–526. https://doi.org/10.1016/j.worlddev.2007.03.003.
103. Heredia, R.M.; Torres, B.; Cayambe, J.; Ramos, N.; Luna, M.; Diaz-Ambrona, C.G.H. Sustainability Assessment of Smallholder Agroforestry Indigenous Farming in the Amazon: A Case Study of Ecuadorian Kichwas. *Agronomy* **2020**, *10*, 1973. https://doi.org/10.3390/agronomy10121973.
104. Heredia, R.M.; Torres, B.; Vasseur, L.; Puhl, L.; Barreto, D.; Díaz-Ambrona, C.G.H. Sustainability Dimensions Assessment in Four Traditional Agricultural Systems in the Amazon. *Front. Sustain. Food Syst.* **2022**, *5*, 782633. https://doi.org/10.3389/fsufs.2021.782633.
105. Weiler, A.; Albertini, S.; Barreto, D.; Heredia, M. Evaluación de la sustentabilidad a escala de sistemas silvopastoriles en tres ecorregiones del Paraguay. *Rev. Amaz. Cienc. Y Tecnol.* **2019**, *8*, 24–39. Available online: https://revistas.proeditio.com/revistamazonica/arti-cle/view/3364 (accessed on 26 January 2022).
106. Heredia, R.M.; Cayambe, J.; Noguera, L.; Torres, A.; Barreto, D.; Andi, Y.; Torres, B.; Bravo, C.; Alemán, R. Sostenibilidad en el Territorio Ancestral Waorani: Caso Producción de Cacao. Memorias del Primer Simposio Internacional Innovaciones Tecnológicas para Fortalecer la Cadena de Cacao en la Amazonía Ecuatoriana, La Joya de los Sachas, Ecuador, 10–11 July 2019; En Caicedo, C., Díaz, A., Eds.; 2020; pp. 1–4. Available online: https://www.researchgate.net/publication/348375470_Sostenibilidad_en_el_Territorio_Ancestral_Waorani_Caso_Produccion_de_Cacao (accessed on 3 March 2022).
107. Heredia, R.M.; Torres, B.; Guerrero, E.; Gallardo, D.; Núñez, M.; Alemán, R.; Cayambe, J.; Díaz-Ambrona, C.G.H. Evaluación de la sostenibilidad de sistemas productivos en la franja de diversidad y vida: Reserva de biosfera yasuní, ama-zonía. *AXIOMA* **2020**, *22*, 5–11.
108. Instrumento para la evaluación del desempeño agroecológico (TAPE)-Versión de prueba. 2021. Available online: https://www.fao.org/documents/card/es/c/ca7407es (accessed on 15 January 2022).
109. Mottet, A.; Bicksler, A.; Lucantoni, D.; De Rosa, F.; Scherf, B.; Scopel, E.; López-Ridaura, S.; Gemmil-Herren, B.; Kerr, R.B.; Sourisseau, J.-M.; et al. Assessing Transitions to Sustainable Agricultural and Food Systems: A Tool for Agroecology Performance Evaluation (TAPE). *Front. Sustain. Food Syst.* **2020**, *4*. https://doi.org/10.3389/fsufs.2020.579154.
110. Heredia, R.M.; Cayambe, J.; Schorsch, C.; Toulkeridis, T.; Barreto, D.; Poma, P.; Villegas, G. Multitemporal Analysis as a Non-Invasive Technology Indicates a Rapid Change in Land Use in the Amazon: The Case of the ITT Oil Block. *Environments* **2021**, *8*, 139. https://doi.org/10.3390/environments8120139.
111. Heredia, R.M.; Torres, B.; Cabrera-Torres, F.; Torres, E.; Díaz-Ambrona, C.G.H.; Pappalardo, S.E. Land Use and Land Cover Changes in the Diversity and Life Zone for Uncontacted Indigenous People: Deforestation Hotspots in the Yasuní Biosphere Reserve, Ecuadorian Amazon. *Forests* **2021**, *12*, 1539. https://doi.org/10.3390/f12111539.
112. Heredia, R.M.; Falconí, K.; Cayambe, J.; Becerra, S. Pedagogical Innovation: Towards Conservation Psychology and Sustainability. *Univers. J. Educ. Res.* **2021**, *9*, 771–780. https://doi.org/10.13189/ujer.2021.090409.
113. García, C.R.; Brown, S. Assessing water use and quality through youth participatory research in a rural Andean watershed. *J. Environ. Manag.* **2009**, *90*, 3040–3047. https://doi.org/10.1016/j.jenvman.2009.04.014.
114. Ngongoni, N.T.; Mapiye, C.; Mwale, M.; Mupeta, B. Factors affecting milk production in the smallholder dairy sector of Zimbabwe. *Livest. Res. Rural Dev.* **2006**, *18*, 1–21.
115. Valdivia, C.; Quiroz, R. Coping and Adapting to Increased Climate Variability in the Andes. In Proceedings of the American Agricultural Economics Association Annual Meeting, Montreal, QC, Canada, 27–30 July 2003; pp. 1–28.
116. Kristjanson, P.; Krishna, A.; Radeny, M.; Kuan, J.; Quilca, G.; Sanchez-Urrelo, A.; Leon-Velarde, C. Poverty dynamics and the role of livestock in the Peruvian Andes. *Agric. Syst.* **2007**, *94*, 294–308. https://doi.org/10.1016/j.agsy.2006.09.009.
117. SENPLADES. *Plan Nacional del Buen Vivir 2013–2017*; Secretaría Nacional de Planificación y Desarrollo: Quito, Ecuador, 2013.
118. FAO. Panorama de la Seguridad alimentaria. Quito, Ecuador: Organización de las Naciones Unidas Para la Alimentación y la Agricultura. 2014. Available online: http://www.fao.org/3/a-i4018s.pdf (accessed on 4 January 2022).
119. Eche, D. Migración y renovación generacional en la agricultura familiar indígena: Estudio de caso Otavalo-Ecuador. *Siembra* **2018**, *5*, 1–15.
120. ILO. Cooperatives and the World of Work Series No. 5. Securing Rights, Creating Jobs and Ensuring Sustainability: A Co-operative Way for Empowering Indigenous Peoples. Available online: https://tinyurl.com/y2oxabjm (accessed on 4 January 2022).
121. Dhir, R.K. *Indigenous Peoples in the World of Work in Asia and the Pacific: A Status Report*; ILO: Geneva, Switzerland, 2015.
122. Morales Ramirez, M.A. Strategies for youth employment in an informal economy. *Rev. Latinoam. Derecho Soc.* **2016**, *23*, 89–121.
123. Balezentis, T.; Morkunas, M.; Volkov, A.; Ribasauskiene, E.; Streimikiene, D. Are women neglected in the EU agriculture? Evidence from Lithuanian young farmers. *Land Use Policy* **2021**, *101*, 105129.
124. Qingqi, W. The Way of Yin: The Chinese Construction of Ecofeminism in a Cross-Cultural Context. *ISLE: Interdiscip. Stud. Lit. Environ.* **2014**, *21*, 749–765. https://doi.org/10.1093/isle/isu148.
125. Arora-Jonsson, S.; Sijapati, B.B. Disciplining Gender in Environmental Organizations: The Texts and Practices of Gender Mainstreaming. *Gend. Work Organ.* **2017**, *25*, 309–325. https://doi.org/10.1111/gwao.12195.
126. Irving, S.; Helin, J. A World for Sale? An Ecofeminist Reading of Sustainable Development Discourse. *Gend. Work Organ.* **2017**, *25*, 264–278. https://doi.org/10.1111/gwao.12196.

127. Finzer, E. Mother Earth, Earth Mother: Gabriela Mistral as an Early Ecofeminist. *Hispania* **2015**, *98*, 243–251. https://doi.org/10.1353/hpn.2015.0058.
128. Salleh, A. *Ecofeminism as Politics*, 2nd ed.; Zed Books: London, UK, 2017.
129. MacGregor, S. From care to citizenship: Calling ecofeminism back to politics. *Ethics Environ.* **2004**, *9*, 56–84.
130. Brown, P.; James, D. Educational expansion, poverty reduction and social mobility: Reframing the debate. *Int. J. Educ. Res.* **2020**, *100*, 101537. https://doi.org/10.1016/j.ijer.2020.101537.
131. Caplan, B. *The Case Against Education: Why the Education System is a Waste of Time and Money*; Princeton University Press: Princeton, NJ, USA, 2018.
132. Bourdieu, P.; Passeron, J.C.; Nice, R. *Education, Society and Culture*; Trans. Richard Nice. SAGE Publications: London, UK, 1977.
133. Levin, H.M.; Kelley, C. Can education do it alone? *Econ. Educ. Rev.* **1994**, *13*, 97–108.
134. Mojo, D.; Fischer, C.; Degefa, T. The determinants and economic impacts of membership in coffee farmer cooperatives: Recent evidence from rural Ethiopia. *J. Rural Stud.* **2017**, *50*, 84–94.
135. Abate, G.T.; Francesconi, G.N.; Getnet, K. Impact of agricultural cooperatives on smallholders' technical efficiency: Empirical evidence from ethiopia. *Ann. Public Coop. Econ.* **2014**, *85*, 257–286. https://doi.org/10.1111/apce.12035.
136. Ji, C.; Jin, S.; Wang, H.; Ye, C. Estimating effects of cooperative membership on farmers' safe production behaviors: Evidence from pig sector in China. *Food Policy* **2019**, *83*, 231–245. https://doi.org/10.1016/j.foodpol.2019.01.007.
137. Chagwiza, C.; Muradian, R.; Ruben, R. Cooperative membership and dairy performance among smallholders in Ethiopia. *Food Policy* **2016**, *59*, 165–173. https://doi.org/10.1016/j.foodpol.2016.01.008.
138. Wynne-Jones, S. Understanding farmer co-operation: Exploring practices of social relatedness and emergent affects. *J. Rural Stud.* **2017**, *53*, 259–268. https://doi.org/10.1016/j.jrurstud.2017.02.012.
139. Kyotos, K.B.; Oduma, J.; Wahome, R.G.; Kaluwa, C.; Abdirahman, F.A.; Opondoh, A.; Mbobua, J.N.; Muchibi, J.; Bagnol, B.; Stanley, M.; et al. Gendered Barriers and Opportunities for Women Smallholder Farmers in the Contagious Caprine Pleuropneumonia Vaccine Value Chain in Kenya. *Animals* **2022**, *12*, 1026. https://doi.org/10.3390/ani12081026.
140. Zheng, S.; Wang, Z.; Awokuse, T. Determinants of Producers' Participation in Agricultural Cooperatives: Evidence from Northern China. *Appl. Econ. Perspect. Policy* **2011**, *34*, 167–186. https://doi.org/10.1093/aepp/ppr044.
141. Barham, J.; Chitemi, C. Collective action initiatives to improve marketing performance: Lessons from farmer groups in Tanzania. *Food Policy* **2009**, *34*, 53–59. https://doi.org/10.1016/j.foodpol.2008.10.002.
142. León-Velarde, C.U.; Quiroz, R. The development of livestock production systems in the Andean region: Implications for smallholder producers. In *Animal Production and Animal Science Worldwide: A Review on Developments and Research in Livestock Systems,* World Association of Animal Production: Lima, Peru, 2003; pp. 233–240.
143. Mumba, C.; Samui, K.L.; Pandey, G.S.; Hang'ombe, B.M.; Simuunza, M.; Tembo, G.; Muliokela, S.W. Economic analysis of the viability of smallholder dairy farming in Zambia. *Livest. Res. Rural Dev.* **2011**, *23*, 137. Available online: http://www.lrrd.org/lrrd23/6/mumb23137.html (accessed on 27 January 2022).
144. Ruvuga, P.R.; Wredle, E.; Mwakaje, A.; Selemani, I.S.; Sangeda, A.Z.; Nyberg, G.; Kronqvist, C. Indigenous Rangeland and Livestock Management Among Pastoralists and Agro-pastoralists in Miombo Woodlands, Eastern Tanzania. *Rangel. Ecol. Manag.* **2019**, *73*, 313–320. https://doi.org/10.1016/j.rama.2019.11.005.
145. Whitmarsh, L.; Capstick, S. Perceptions of climate change. In *Psychology and Climate Change*; Clayton, S., Manning, C., Eds.; Academic Press: Cambridge, MA, USA, 2016; pp. 13–33. https://doi.org/10.1016/B978-0-12-813130-5.00002-3.
146. van der Linden, S. The social-psychological determinants of climate change risk perceptions: Towards a comprehensive model. *J. Environ. Psychol.* **2015**, *41*, 112–124. https://doi.org/10.1016/j.jenvp.2014.11.012.
147. Leroy, D. Farmers' Perceptions of and Adaptations to Water Scarcity in Colombian and Venezuelan Páramos in the Context of Climate Change. *Mt. Res. Dev.* **2019**, *39*, R21–R34. https://doi.org/10.1659/mrd-journal-d-18-00062.1.
148. Su, Y.; Bisht, S.; Wilkes, A.; Pradhan, N.S.; Zou, Y.; Hyde, K.; Liu, S. Gendered Responses to Drought in Yunnan Province, China. *Mt. Res. Dev.* **2017**, *37*, 24–34. https://doi.org/10.1659/MRD-JOURNAL-D-15-00041.1.
149. Toulkeridis, T.; Tamayo, E.; Simón-Baile, D.; Merizalde-Mora, M.J.; Yunga, D.F.R.; Viera-Torres, M.; Heredia, M. Climate Change according to Ecuadorian academics–Perceptions versus facts. *La Granja* **2020**, *31*, 21–46. https://doi.org/10.17163/lgr.n31.2020.02.
150. Heredia, R.M.; Barreto, D.; Toulkeridis, T. *Percepción de las Poblaciones Indígenas Kichwa sobre el Cambio Climático y sus Implicaciones en Puyo, Ecuador*; Carrión, A., Ariza-Montobbio, P., Eds.; La acción climática en las ciu-dades latinoamericanas: Aproximaciones y propuestas; FLACSO: Quito, Ecuador, 2020; pp. 209–230, 254p.
151. León Alvear, V.; Torres, B.; Luna, M.; Torres, A.; Ramírez, P.; Andrade-Yucailla, V.; Muñoz-Rengifo, J.C.; Heredia, R.M. Percepción sobre cambio climático en cuatro comunidades orientadas a la ganadería bovina en la zona central de los Andes Ecuatorianos. *Livest. Res. Rural Dev.* **2020**, *32*, 165.
152. Bradley, R.S.; Vuille, M.; Diaz, H.F.; Vergara, W. Threats to Water Supplies in the Tropical Andes. *Science* **2006**, *312*, 1755–1756. https://doi.org/10.1126/science.1128087.
153. Vuille, M.; Francou, B.; Wagnon, P.; Juen, I.; Kaser, G.; Mark, B.; Bradley, R.S. Climate change and tropical Andean glaciers: Past, present and future. *Earth Sci. Rev.* **2008**, *89*, 79–96. https://doi.org/10.1016/j.earscirev.2008.04.002.
154. Perez, C.; Nicklin, C.; Dangles, O.; Vanek, S.; Sherwood, S.; Halloy, S. Climate change in the high Andes: Im-plications and adaptation strategies for small-scale farmers. *Int. J. Environ. Cult. Econ. Soc. Sustain.* **2010**, *6*, 71–88.

155. Thibeault, J.; Seth, A.; Garcia, M.; Mayor, U.; Andrés, D.S.; Paz, L. Changing climate in the Bolivian Altiplano: CMIP3 projections for extremes of temperature and precipitation. *J. Geophys. Res. Atmos.* **2010**, *115*, 2070.
156. Valdivia, C.; Seth, A.; Gilles, J.L.; García, M.; Jiménez, E.; Cusicanqui, J.; Navia, F.; Yucra, E. Adapting to Climate Change in Andean Ecosystems: Landscapes, Capitals, and Perceptions Shaping Rural Livelihood Strategies and Linking Knowledge Systems. *Ann. Assoc. Am. Geogr.* **2010**, *100*, 818–834. https://doi.org/10.1080/00045608.2010.500198.
157. Meldrum, G.; Mijatović, D.; Rojas, W.; Flores, J.; Pinto, M.; Mamani, G.; Condori, E.; Hilaquita, D.; Gruberg, H.; Padulosi, S. Climate change and crop diversity: farmers' perceptions and adaptation on the Bolivian Altiplano. *Environ. Dev. Sustain.* **2017**, *20*, 703–730. https://doi.org/10.1007/s10668-016-9906-4.
158. Nnadi, F.N.; Chikaire, J.; Ezudike, K.E. Assessment of indigenous knowledge practices for sustainable agriculture and food security in Idemili South Local Government Area of Anambra State, Nigeria. *J. Resour. Dev. Manag.* **2013**, *1*, 34–42.
159. Godtland, E.M.; Sadoulet, E.; de Janvry, A.; Murgai, R.; Ortiz, O. The Impact of Farmer Field Schools on Knowledge and Productivity: A Study of Potato Farmers in the Peruvian Andes. *Econ. Dev. Cult. Chang.* **2004**, *53*, 63–92. https://doi.org/10.1086/423253.
160. Afsar, N.; Idrees, M. Farmers perception of agricultural extension services in disseminating climate change knowledge. *Sarhad J. Agric.* **2019**, *35*, 942–947.
161. Antwi-Agyei, P.; Dougill, A.J.; Stringer, L.C.; Codjoe, S.N.A. Adaptation opportunities and maladaptive outcomes in climate vulnerability hotspots of northern Ghana. *Clim. Risk Manag.* **2018**, *19*, 83–93. https://doi.org/10.1016/j.crm.2017.11.003.
162. Juhola, S.; Glaas, E.; Linnér, B.O.; Neset, T.S. Redefining maladaptation. *Environ. Sci. Policy* **2016**, *55*, 135–140.
163. Vásquez, R.P.; Aguilar-Lasserre, A.A.; López-Segura, M.V.; Rivero, L.C.; Rodríguez-Duran, A.A.; Rojas-Luna, M.A. Expert system based on a fuzzy logic model for the analysis of the sustainable livestock production dynamic system. *Comput. Electron. Agric.* **2019**, *161*, 104–120. https://doi.org/10.1016/j.compag.2018.05.015.
164. FAO. *Climate-Smart Agriculture Sourcebook*; FAO: Rome, Italy, 2013; p. 570.
165. Serra, R.; Mckune, S. *Climate Information Services and Behavioral Change: The Case of SENEGAL*; Working Paper Series for Development, Security and Climate Change in the Sahel: Exchange Program between UF, Sciences Po and UCAD; Sahel Research Group: Gainesville, FL, USA, 2016; 22p.
166. Vaughan, C.; Hansen, J.; Roudier, P.; Watkiss, P.; Carr, E. Evaluating agricultural weather and climate services in Africa: Evidence, methods, and a learning agenda. *WIREs Clim. Chang.* **2019**, *10*, e586. https://doi.org/10.1002/wcc.586.
167. Ouédraogo, I.; Diouf, N.S.; Ouedraogo, M.; Ndiaye, O.; Zougmoré, R.B. Closing the Gap between Climate Information Producers and Users: Assessment of Needs and Uptake in Senegal. *Climate* **2018**, *6*, 13. https://doi.org/10.3390/cli6010013.
168. Santiago, C.M.; Díaz, P.R.; Morales-Salinas, L.; Betancourt, L.P.; Fernández, L.O. Practices and Strategies for Adaptation to Climate Variability in Family Farming. An Analysis of Cases of Rural Communities in the Andes Mountains of Colombia and Chile. *Agriculture* **2021**, *11*, 1096. https://doi.org/10.3390/agriculture11111096.
169. Henry, B.K.; Eckard, R.J.; Beauchemin, K.A. Review: Adaptation of ruminant livestock production systems to climate changes. *Animal* **2018**, *12*, s445–s456. https://doi.org/10.1017/s1751731118001301.
170. Cayambe, J.; Iglesias, A. The cost of mitigating greenhouse gas emissions in farms in Central Andes of Ecuador. *Span. J. Agric. Res.* **2020**, *18*, e0101. https://doi.org/10.5424/sjar/2020181-13807.