agriculture

MDPI

Article

Evaluation of the Entrepreneurial Ability of Small-Scale Farmers through the Rasch–Andrich Model

Carlos Alberto Cortés-Rodríguez [1], Gladys Martínez-Gómez [2,*], José Luis Romo-Lozano [3] and Ezequiel Arvizu-Barrón [4]

[1] Departamento de Sociología Rural, Universidad Autónoma Chapingo, Km. 38.5 Carretera México-Texcoco, Chapingo, Texcoco 56230, Mexico; al19133394@chapingo.mx
[2] Departamento de Preparatoria Agrícola, Universidad Autónoma Chapingo, Km. 38.5 Carretera México-Texcoco, Chapingo, Texcoco 56230, Mexico
[3] División de Ciencias Forestales, Universidad Autónoma Chapingo, Km. 38.5 Carretera México-Texcoco, Chapingo, Texcoco 56230, Mexico; jromol@chapingo.mx
[4] Dirección de Vinculación, Colegio de Postgraduados-Campus Montecillo, Km. 36.5 Carretera Federal México-Texcoco, Montecillo 56264, Mexico; arvizu@colpos.mx
* Correspondence: gmartinezg@chapingo.mx

Abstract: Entrepreneurial skills are fundamental to the success of agricultural production units. Since small-scale farmers have developed production skills but not market-oriented skills, it is necessary to assess their entrepreneurial skills to provide a reference for sustainable community development plans. The objective was to evaluate the entrepreneurial ability of small-scale farmers in San Pablo Huixtepec, Oaxaca, using the Rasch–Andrich rating scale, a psychometric model that makes it possible to obtain measurements with a certain degree of precision. A survey was conducted among 45 small-scale farmers to collect the characteristics of their production unit, the characteristics of the small-scale farmers, and to determine their entrepreneurial skills (17 items). The data were processed using Winsteps software. Item 14 "I easily market what I produce" was eliminated because it did not contribute to the unidimensionality of the variable. The data fit the model and the Rasch–Andrich thresholds and, together with the category probability curves, demonstrated the good performance of the rating scale. The entrepreneurial ability ranged from −1.54 to 10.11 logits. Since most of producers (66.6%) were below average (1.09 logits), it is considered pertinent to support them to improve their ability.

Keywords: market access; agricultural entrepreneurship; unit development; rating scale

Citation: Cortés-Rodríguez, C.A.; Martínez-Gómez, G.; Romo-Lozano, J.L.; Arvizu-Barrón, E. Evaluation of the Entrepreneurial Ability of Small-Scale Farmers through the Rasch–Andrich Model. *Agriculture* **2023**, *13*, 721. https://doi.org/10.3390/agriculture13030721

Academic Editor: Jean-Paul Chavas

Received: 5 February 2023
Revised: 2 March 2023
Accepted: 19 March 2023
Published: 21 March 2023

1. Introduction

Entrepreneurial ability is one of the factors that contributes to the success of agricultural production units [1,2]. This phenomenon has been the focus of attention due to its relationship with job creation, innovation, growth, and economic development [3–5]. This ability contributes to the development of production units and can be a way to overcome the limitations of economic development and the low performance of the agricultural sector in San Pablo Huixtepec, Oaxaca [4]. In view of the fact that production units have been facing problems related to the market [6], small-scale farmers in this municipality must develop the necessary skills for success [7]. For this reason, it is considered appropriate to explore their entrepreneurial skills in order to train them find creative ways to enter the market and increase the productivity of the sector, thereby improving their quality of life [3]. This covers two objectives set by the United Nations (UN). One is the promotion of sustainable development for poverty eradication, and the other is the promotion of economic growth and full and productive employment [8].

For the purposes of this research, a farmer is a person who devotes part or all of his or her time to a variety of activities on a production unit that is his or her main

source of income [9]. Entrepreneurial ability is defined as the ability to put knowledge into practice for the growth of the productive unit and the obtaining of profits [3,10]. For Salau et al. [5], it represents the ability to capture commercial opportunities and to explore, allocate, coordinate, and manage the resources of the production unit for optimal productivity. According to Babu et al. [11], this capability is significantly stronger in traditional production practices than in market-oriented ones.

Detecting the entrepreneurial ability of small-scale farmers allows locating the knowledge they use to achieve their economic goals [2] and identifying their weaknesses to design training that will allow them to prosper in agriculture [12]. In a literature review by Dias et al. [7], in which they compared publications between 1969 and 2012, as opposed to 2013–2017, they noted that most of the literature on entrepreneurship concentrated on services, manufacturing, and high technology; however, little was published on entrepreneurial skills in underdeveloped regions where agricultural activity is prevalent. The study of general entrepreneurial ability has been prioritized [13–17], and that related to entrepreneurial ability in agriculture has been less addressed [5,18,19].

The configuration of skill Is specific to each region, considering culture and economic level [1]. One of the conclusions reached by McElwee [9] in his work on competitive skills in the agricultural sector was that it is necessary to educate and train farmers to increase their skills. This can be achieved by developing specific policies that address the specific skills of the beneficiaries. For this reason, a specific study of small-scale farmers is required in terms of knowing their capabilities, establishing intervention strategies, and coordinating efforts for sustainable community development [20].

This research aims to evaluate entrepreneurial ability based on the Rasch–Andrich rating scale, a proposal that emerged in 1978 from the work of David Andrich, who adapted George Rasch's dichotomous model to process polytomous data [21]. It is part of the Rasch family of models [22] and relies on item response theory to assess the reliability and validity of data in a measurement [23]. It is useful for constructing measurements from items with multiple response categories [22,24] and analyzes to what extent the responses obtained in the items are close to the expected pattern to construct a linear measure [24].

This model has been used to calibrate scales, instruments, and tests to verify their validity and reliability for the construction of measurements in various areas such as education, the health sciences, and the social sciences [25–29]. However, no studies were found in which this model was applied to verify the validity and reliability of scales, tests, or instruments aimed at measuring the entrepreneurial skills of small-scale farmers [12].

The ability of a farmer is not something that can be measured directly; rather, it is conceptualized by a straight line with units of equal intervals, expressed in units of log odds or simply in units of logit [21]. Most research that uses ordinal scales, i.e., ordered response categories such as Likert scales [5,19,30,31], have used these scales as equal intervals when they may be unequal and have processed them using statistics to draw conclusions that may be erroneous [32]. According to Boone [33], this has been one of the most common problems in research because of the possibility of making mistakes when analyzing scales without prior processing. To provide a solution to this subjectivity in the responses, it was decided to quantify the entrepreneurial ability based on the Rasch–Andrich model. This model ensures equal (linear) intervals, allowing for a more accurate measurement and overcoming the limitations of measurements based on classical test theory [33].

The model enables the items of an instrument to be evaluated to accurately quantify entrepreneurial ability. To achieve this goal, it is necessary to perform a series of analytical steps. First, the instrument must be unidimensional, meaning that the items that comprise it must be built on one primary dimension [26]. Second, the data must fit the chosen model [34]; there must be separation between farmers' entrepreneurial ability and the items of the instrument [22,23], and the order of difficulty of the entrepreneurial ability and items must be replicated [21]. Third, the rating scale must function correctly in the assessment [35]. Once the reliability and validity of the instrument have been analyzed, the measurements of entrepreneurial ability are obtained [21].

2. Materials and Methods

2.1. Study Area

This research was conducted in May 2022 with small-scale farmers in San Pablo Huixtepec, Oaxaca (Figure 1). Of the 169 municipalities in the Valles Centrales region, it ranks fourth in terms of agricultural production value. This value is estimated at USD 4,253,904 [36]. It is located at geographic coordinates 16°49′6″ north latitude and 96°46′58″ west longitude, at an altitude of 1484 m above sea level, with a sub-humid climate with summer rains (ACW) and an average annual temperature of 14.1 °C. It borders to the north with San Nicolás Quialana, to the south with Santa Gertrudis and San José Guelatová, to the east with Santa Inés Yatzeche, and to the west with Vigallo.

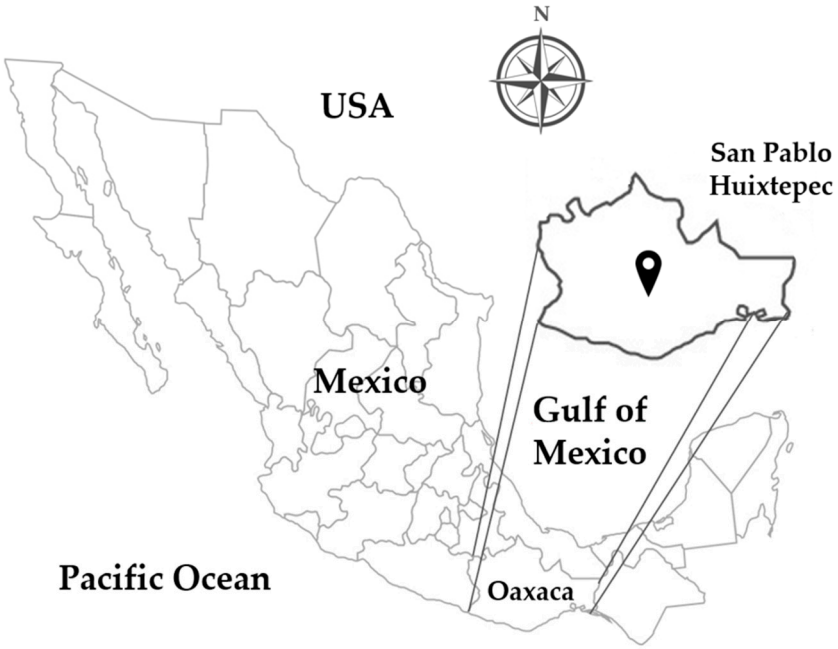

Figure 1. Location of the study area.

2.2. Data Collection Instrument

A convenience sampling based on a population of 345 farmers was used, and although it represents a bias, it enables the researcher to obtain data from the actors who can take part in the study, based on their willingness to answer a survey, without the need for probability sampling [37]; this represented 13.0% of the population. The data were collected through a survey, a social research technique designed in this research to collect information from the actors about the productive unit and entrepreneurial skills. As this research is part of a broader project, the survey arose from a bibliometric analysis [12] of the importance of training for agricultural entrepreneurship and from there the need to know the entrepreneurial skills. This instrument considered 17 items (Table 1) with a Likert scale of five categories: very low (0), low (1), regular (2), high (3), and very high (4). The data were processed in the software Winsteps v. 5.2.5 [38].

Table 1. Items used to assess entrepreneurial ability.

Item	Description
i1	I can search for information for the benefit of my productive unit.
i2	I can identify opportunities for the growth of my production unit.
i3	I promote innovation in my production unit.
i4	I manage risks so that my productive unit thrives.
i5	I can complete my production unit's proposed activities.
i6	I rely on my network of contacts for the promotion of my production unit and my products.
i7	I cooperate with other farmers.
i8	I know how to set up a business in a formal way.
i9	I have a clear understanding of the value of my product to my customers.
i10	I know how to get credit from banks.
i11	I can easily manage the expenses and profits of my production unit.
i12	I plan and organize my production unit's activities.
i13	I know the objectives to follow for the development of my productive unit.
i14	I market my products easily.
i15	I know the needs of my customers.
i16	I can manage my temporary workers.
i17	I can use technologies (ICT) for the development of my productive unit.

Source: author's elaboration based on Cortés-Rodríguez et al. [12].

2.3. Data Analysis

Entrepreneurial ability was quantified by means of the Rasch–Andrich model, which allows handling items with rating scales similar to the Likert scale [22]. This model specifies the probability, P_{nij}, that farmer n of skill β_n will be observed in category j of a rating scale applied to item i of difficulty δ_i, as opposed to the probability $P_{ni(j-1)}$ of being observed in category $(j-1)$. In the formula below, τ_j is the 'Rasch–Andrich threshold' [21]:

$$\mathrm{Log_e}\,(P_{nij}/P_{ni(j-1)}) = \beta_n - \delta_i - \tau_j \quad (1)$$

The following analytical steps were taken to evaluate the instrument and accurately quantify the entrepreneurial ability:

- Unidimensionality. This refers to the value of the first contrast in principal components analysis, which allows determining the construct's only dimension. Entrepreneurial ability can be considered unidimensional if the calculated value is less than 2.0. Another way to determine this is by using the internal-pattern-sensitive fit statistic (Infit) and the outlier-sensitive fit statistic (Outfit) for both items and individuals [26]. In this case, the mean squares of the Infit and Outfit statistics should fluctuate between 0.5 and 1.5 [34].
- Item fit and entrepreneurial ability. The mean squares of the Infit and Outfit statistics were estimated and were also useful in the assessment of item fit and entrepreneurial ability in the model [39]. The point–biserial correlation was obtained on the items to ensure they were aligned in the same direction as entrepreneurial ability. This was achieved by obtaining correlations greater than 0.2 [23]. In order to determine the extent to which the observed dataset approximated that expected by the model, exact matches were generated. If the observation rate is greater than the expectation rate, the data are more predictable, but if this relationship is the opposite, the data are more random [38]. The separation index was examined to determine whether the model adequately discriminated both the items and the entrepreneurial ability of farmers

along the common measurement line [21]. This was achieved by obtaining separation values greater than 2.0 [26]. The reliability index was calculated in order to determine whether the order of difficulty of the items and the entrepreneurial ability could be reproduced, which was achieved by obtaining reliability values close to 1.0 [26].

- Performance of the rating scale. The proper functioning of the Likert scale was verified by three tests: first, the Infit and Outfit fit statistics in the rating categories, which should be close to 1.0; second, the Rasch–Andrich thresholds, which should increase as one moves to a higher rating category; and third, the highest points on each category probability curve, which should not be below any adjacent curve [35].

Once the aforementioned principles were met, we proceeded to the graphical representation of the entrepreneurial ability and item difficulty in a Wright map [33]. This map was designed by Ben Wright in 1999 and is composed of two histograms vertically placed, each with its respective mean, its standard deviation, and two standard deviations, which are indicators of the dispersion of the data [38]. On the left side, the farmers are placed according to their level of entrepreneurial ability, with those at the top being the most capable and those at the bottom being the least capable. On the right side, the items are placed, from the most difficult to the least difficult to carry out [33]. Both farmers and items are distributed on the same measurement line and therefore share units in logits. Theoretically, there is a 50% probability that a producer will respond favorably to an item when the producer's entrepreneurial ability is placed at the same level as the item [21].

3. Results

3.1. Characteristics of Small-Scale Farmers

According to Table 2, the respondents were predominantly male (91.1%), which contrasts with the study by Becot et al. [20], where the sex variable was more balanced. The sample consisted of farmers who were on average 55.5 years old, which is considered older than the age reported in other studies [40,41]. Even though some respondents had no formal education (8.9%), and a large part of them studied at a basic level, i.e., primary and secondary school (68.9%), their performance in agriculture was favored by the acquired experience (37.8 years on average) and extensive technical knowledge. Consistently, Becot et al. [20] found that small-scale farmers acquired the knowledge and skills necessary to run their production unit through experience and not necessarily in a formal educational environment.

The main reason why the small-scale farmers decided to go into farming was because of family tradition (43.4%). In fact, they learned farming activities at very early stages from grandparents, parents, and uncles. The second cause for taking up agriculture was economic need (30.3%), and the third was employment need (23.7%), which is consistent with what was stated by other farmers in India who chose to run a productive unit to have an income and avoid unemployment [40]. These findings suggest that small-scale farmers have created their production unit out of necessity and not precisely out of the identification of an economic opportunity in the market.

The majority (71.1%) reported engaging in other activities in addition to agriculture as a way to complement their income. There is a growing consensus that low-income farmers are not completely dependent on agriculture but tend to diversify into nonagricultural activities, such as construction and transportation services, to increase their resources [42]. Nevertheless, for the respondents, farm work accounted for 68% of their economic income. They are at greater risk of abandoning the sector and migrating in search of better opportunities, given the problem of low profitability in agriculture [43].

Table 2. Descriptive statistics of farmers.

Variable		Frequency	Percentage
Sex	Female	4	8.9
	Male	41	91.1
Age	≤30	2	4.4
	31–45	15	33.3
	46–60	8	17.8
	≥61	20	44.4
Education level	No education	4	8.9
	Primary	19	42.2
	Secondary	12	26.7
	High School	8	17.8
	Bachelor's Degree	2	4.4
Experience in agriculture	≤20	11	24.4
	21–40	16	35.6
	41–60	12	26.7
	≥61	6	13.3
Reason for engaging in agriculture *	For enjoyment	2	2.6
	Economic need	23	30.3
	Labor need	18	23.7
	Family tradition	33	43.4
The farmer has another job besides farming	Yes	32	71.1
	No	13	28.9
Percentage of income from agriculture	1–20%	6	13.3
	21–40%	2	4.4
	41–60%	19	42.2
	61–80%	4	8.9
	81–100%	14	31.1

* Some farmers answered more than one option.

3.2. Characteristics of the Productive Unit

While it is challenging for small productive units to access economies of scale and negotiate product prices [44], small productive units have shown potential to reduce poverty in rural areas [42]. According to Table 3, the majority of them (71.1%) were not formally constituted, and some operated as a Rural Production Society (24.4%), Limited Company (2.2%), or Civil Association (2.2%). These farms employed on average 4.8 seasonal workers and planted 3.9 hectares of land, which were not necessarily their own, but could have been leased, sharecropped, or a combination of the above. Of the farmers, 44.4% were dedicated to the production of alfalfa to use it in green, to make bales, and to harvest seed, while 44.4% focused on the production of corn to obtain grain or to make silage, and in smaller percentages were found those who planted beans (4.4%), water chili (2.2%), tomato (2.2%), and organic cucumber for export (2.2%).

Table 3. Descriptive statistics of the productive unit.

Variable		Frequency	Percentage
Type of company	Corporation	1	2.2
	Rural Production Society	11	24.4
	Civil Association	1	2.2
	Not incorporated	32	71.1
Number of temporary workers	1–3	27	60.0
	4–6	15	33.3
	7–9	1	2.2
	≥10	2	4.4
Hectares of cultivation	<2	11	24.4
	2–4	21	46.7
	>4	13	28.9
Crop sown	Alfalfa	20	44.4
	Water chili	1	2.2
	Beans	2	4.4
	Corn	20	44.4
	Organic cucumber	1	2.2
	Tomato	1	2.2
Percentage of production destined for sale	1–20%	15	33.3
	21–40%	3	6.7
	41–60%	7	15.6
	61–80%	7	15.6
	81–100%	13	28.9
Sell online	Yes	2	4.4
	No	43	95.6
Performance of the productive unit	Good	17	37.8
	Fair	27	60.0
	Poor	1	2.2
Stage of the productive unit	Consolidated	3	6.7
	Developing	29	64.4
	Stagnant	13	28.9

The production was intended for self-consumption (56.0%), with the surplus for commercialization (44.0%), marketed locally (86.7%), nationally (11.1%), and internationally (2.2%). The agricultural market access generally has been difficult because of the remoteness from urban markets, high input costs, low purchase prices, fewer buyers, and limited access to venture support services [4]. This situation has contributed to the low yield of the productive units. There were minimal cases of internet sales (4.4%) through Facebook and WhatsApp. This was explained by the fact that the small scale-farmers were mostly adults and did not show ICT skills compared to younger ones [45].

Most productive units showed a regular (60.0%) and good (37.8%) performance in the economic activities carried out. It is noteworthy that no productive unit declared a very good performance, and that most of the opinions were concentrated in a regular level, which suggests an opportunity for improvement. Most of the participants reported development (64.4%) and stagnation (28.9%), while a small proportion reported consolidation (6.7%).

Becot et al. [20] also found that the majority of them were in a developing phase. Given that the performance of productive units is not ideal and that they are at a developmental stage where they require guidance, it is essential to train small farmers to strengthen their entrepreneurial skills and consequently have better yields [11].

3.3. Measurement of Entrepreneurial Ability

3.3.1. Unidimensionality

The value of the first contrast of the principal component analysis of the standardized residuals was 3.3. Since this result was greater than 2.0, the entrepreneurial ability could not be considered one-dimensional, and item 14, stating "I easily market what I produce", had to be eliminated to meet this criterion. It was eliminated because the mean squares in the Infit (1.49) and Outfit (1.77) had high values. When the analysis was recalculated, all the values in the Infit and Outfit were in the range of 0.5 to 1.5 (Table 4), thus achieving the unidimensionality of the construct [26].

Table 4. Fit statistics on the items and on the entrepreneurial ability of the small-scale farmers.

Item	Measure	Model S.E.	Infit		Outfit		PTBISERL-EX		Exact Match	
			MNSQ	ZSTD	MNSQ	ZSTD	Corr.	Exp.	Obs%	Exp%
i1	0.04	0.27	0.61	−2.16	0.71	−1.07	0.60	0.55	68.9	61.2
i2	0.04	0.27	0.58	−2.33	0.61	−1.53	0.63	0.55	64.4	61.2
i3	0.11	0.26	0.76	−1.20	0.83	−0.54	0.66	0.55	68.9	61.3
i4	−1.29	0.32	1.35	1.34	1.42	1.02	0.44	0.50	66.7	74.4
i5	−1.84	0.35	1.17	0.69	1.26	0.65	0.43	0.49	73.3	78.2
i6	3.66	0.28	1.43	1.72	1.34	1.36	0.39	0.61	62.2	67.6
i7	1.52	0.25	1.34	1.62	1.36	1.58	0.53	0.60	42.2	58.8
i8	2.29	0.26	0.90	−0.45	0.90	−0.42	0.73	0.61	55.6	60.6
i9	−1.29	0.32	0.69	−1.28	0.75	−0.51	0.57	0.50	84.4	74.4
i10	1.96	0.25	1.14	0.75	1.07	0.39	0.67	0.61	53.3	59.0
i11	−0.65	0.29	1.09	0.48	1.14	0.50	0.34	0.52	60.0	68.6
i12	−1.84	0.35	0.75	−0.90	0.83	−0.21	0.40	0.49	86.7	78.2
i13	−1.19	0.31	0.88	−0.40	0.99	0.12	0.65	0.50	77.8	73.8
i15	−1.72	0.34	0.69	−1.16	0.70	−0.52	0.50	0.49	84.4	77.7
i16	−1.96	0.35	0.74	−0.93	0.75	−0.43	0.63	0.48	84.4	78.6
i17	2.16	0.26	1.01	0.12	0.95	−0.16	0.64	0.61	53.3	59.4
Items										
Mean	0.00	0.29	0.95	−0.25	0.97	0.02	-	-	67.9	68.3
SD	1.74	0.04	0.27	1.23	0.25	0.83	-	-	12.9	7.8
Separation	5.51									
Reliability	0.97									
EASSF										
Mean	1.09	0.50	0.98	−0.12	0.97	−0.14	-	-	67.9	68.3
SD	1.87	0.10	0.44	1.13	0.57	1.12	-	-	13.0	6.6
Separation	3.23									
Reliability	0.91									

Model S.E. = standard error of the model; Infit = inlier-pattern-sensitive fit statistic; Outfit = outlier-sensitive fit statistic; MNSQ = mean square; ZSTD = standardized t-fit statistics; PTBISERL-EX = point–biserial correlation excluding the current observation from the raw score; Corr. = observed correlation; Exp. = expected correlation; Obs% = observed percentage; Exp% = expected percentage; SD = standard deviation; EASSF = entrepreneurial ability of small-scale farmers.

3.3.2. Item Fit and Entrepreneurial Ability

The mean of the mean squares (MNSQ) of the Infit and Outfit of the items as well as the entrepreneurial ability were close to 1.0 (Table 4). This indicated a good fit of the data [21]. When the mean squares are very high, with values over 1.5, the data deteriorate the measurement. Values below 0.5, while not degrading the measurement, are less productive and can produce misleading separation and reliability coefficients [34,39]. As can be seen, the values fluctuated within the permissible limits, which allowed affirming that the data contributed to an accurate measurement of entrepreneurial ability. The relevance of the items with the number of producers in this study was sufficient to declare a fit of the data. In general, because misfitting of items raises questions about test administration, data accuracy, and construct definition, stricter tuning rules were applied at the item level than at the entrepreneurial ability level [39].

It is worth noting that item 11, which asks, "I can easily manage the expenses and profits of my production unit." received the lowest point–biserial correlation value, excluding the current observation of the raw score (PTBISERL-EX), which was 0.34 (Table 4). In contrast, item 8, "I know how to set up a business in a formal way" had the highest correlation of 0.73. Given that all the items obtained correlations above 0.2 [23], it can be affirmed that they were aligned in the same direction as entrepreneurial ability. In addition, the correlation observed in the data was close to the expectation of the model.

For both the items and producers' entrepreneurial ability, the average of the observed exact matches was 67.9% (Table 4). Since this percentage was slightly lower than expected (68.3%), the data had random behavior, i.e., they were less predictable for the model [38]. Correct discrimination along the common measurement scale was determined, as the item separation index (5.51) and entrepreneurial ability of the farmers (3.23) were higher than 2.0 [26] (Table 4). The reliability index of the items (0.97) and entrepreneurship (0.91) was close to 1.0. Therefore, it was determined that the order of difficulty of the items and the entrepreneurial ability could be replicated [26].

3.3.3. Operation of the Rating Scale

According to the data (Table 5), the farmers used the "high" response category (355 times) and the "regular" response category (203 times) more frequently. The rating scale worked well because the average measure increased ($-3.30 < -1.93 < 0.23 < 2.18 < 6.80$) when moving to a higher Likert scale category ($0 < 1 < 2 < 3 < 4$) [26]. The Infit MNSQ and Outfit MNSQ statistics were close to 1.0, indicating a good fit of the categories [35]. The Rasch–Andrich thresholds were desirable because they increased with the increasing rating category ($-5.35 < -1.39 < 0.62 < 6.13$) [23,35].

Table 5. Structure of categories.

Category	Observed Count	Average Measure	Infit MNSQ	Outfit MNSQ	Rasch–Andrich Threshold
Very low (0)	8	−3.30	0.98	1.03	None
Low (1)	121	−1.93	0.77	0.69	−5.35
Regular (2)	203	0.23	1.10	1.12	−1.39
High (3)	355	2.18	0.96	0.88	0.62
Very high (4)	33	6.80	1.05	1.17	6.13

The category probability curves (Figure 2) made it possible to check that the highest points on each category curve did not fall below any of the adjacent curves [35]. To summarize, the five-point Likert scale was suitable for quantifying entrepreneurial ability.

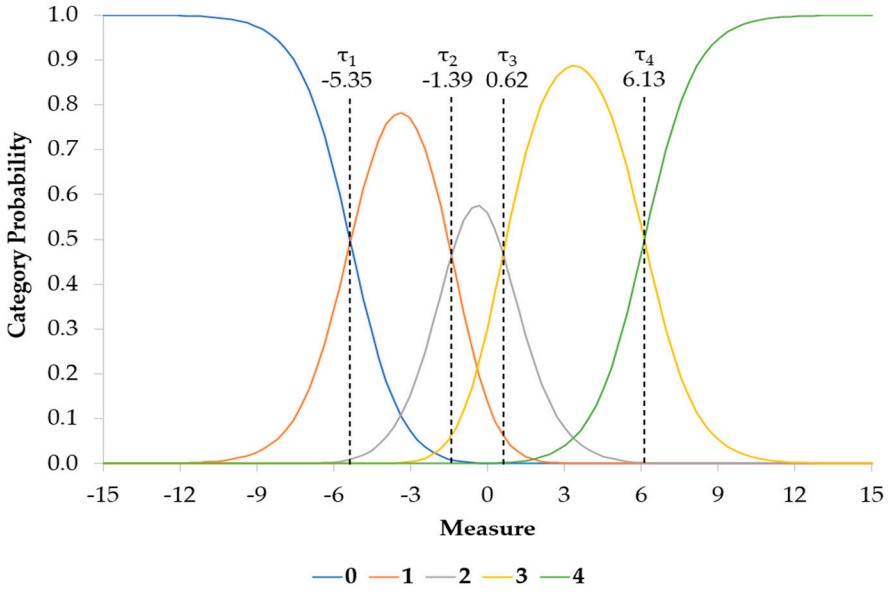

Figure 2. Category probability curves.

3.3.4. Entrepreneurial Ability

On the left side of the Wright map (Figure 3), the entrepreneurial ability ranged from −1.54 to 10.11 logits. More than half of the farmers (66.6%) were below the average ability, estimated at 1.09 logits. The three farmers with the lowest ability were 1, 14, and 4 with −1.54, −1.36, and −1.18 logits, respectively. In contrast, the three farmers with the highest ability obtained 10.11, 3.87, and 3.57 logits, respectively. The ability of one of the farmers attracted attention because it was significantly higher than the rest of the actors with 10.11 logits. In general, most of them were clustered at the lower end of the measurement scale, suggesting an area for improvement in entrepreneurial ability.

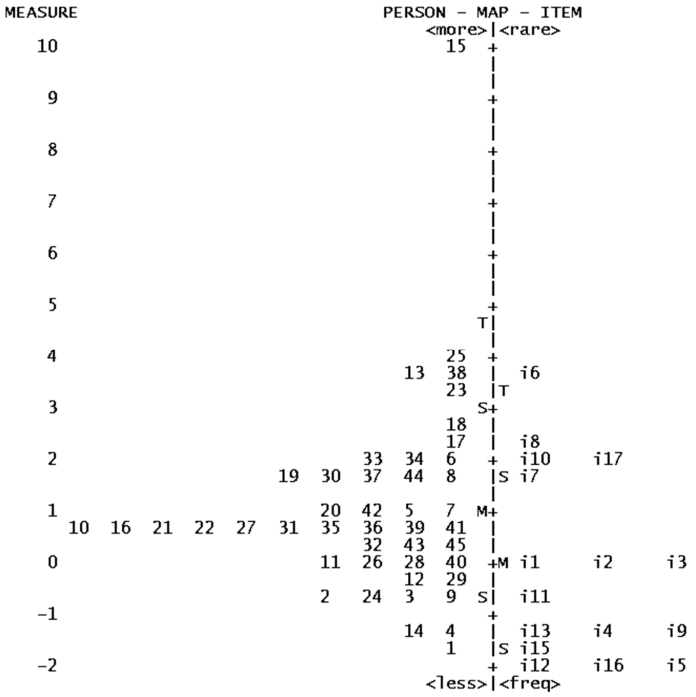

Figure 3. Wright map, distribution of small-scale farmers and items. M = mean; S = standard deviation; T = two standard deviations.

On the right side of the Wright map (Figure 3), the difficulty of the items varied between −1.96 and 3.66 logits. The items with the least difficulty for farmers were i16 (I am able to manage my temporary workers), i12 (I plan and organize my production unit's activities), and i5 (I am able to complete my production unit's proposed activities), with −1.96, −1.84, and −1.84 logits, respectively. On the other hand, the most difficult items to achieve were i6 (I rely on my network of contacts for the promotion of my production unit and my products), i8 (I know how to set up a business in a formal way), and i17 (I am able to use technologies (ICT) for the development of my productive unit), with 3.66, 2.29, and 2.16 logits, respectively. Since 84.4% of the farmers could not meet i17 and i8, and 95.6% could not meet i6, the items that were more complex to implement should be included in nonformal education or training initiatives to improve skills.

4. Discussion

The proposed instrument serves to measure for the first time the entrepreneurial ability based on the item response theory. The Rasch–Andrich model enabled identifying that item 14 (I market my products easily) showed outliers for the Infit (1.49) and Outfit (1.77) statistics, which indicated that this item did not contribute to measuring the entrepreneurial ability. Therefore, it was decided to remove it to meet the criterion of unidimensionality or primary dimension of the variable, to fit the data in the model, and to provide validity to the instrument [26]. Once it was removed from the analysis, the fit statistics of the remaining items ranged from 0.5 to 1.5, which is consistent with related studies in other fields [25,27] and provides support for construct validity. At the person level, 35.5% of the small-scale farmers did not fit the model, which contrasts with the lower value of 15.7% obtained by Arias González et al. [23]. Wright and Linacre [39] argue that as long as item level fit is ensured, the accuracy of the data and the definition of entrepreneurial ability can be achieved; therefore, it is more important to pay attention to the items.

The point–biserial correlations were above 0.2, as in previous analyses [23,46], indicating a relationship between the items and entrepreneurial ability. The exact matches observed were below those expected by the model, which suggests that the data were less predictable, contrary to what was reported in another study [46], where the data were more predictable. The indexes of separation and reliability at the level of items and small-scale farmers' ability showed the desired value, as found in other types of research [23,28], where the separation of items and individuals along the line of measurement was confirmed, as well as the reproducibility of the difficulty of both items and individuals, showing the reliability of the instrument to be applied to other individuals. Regarding the fit statistics in each category, the Rasch–Andrich thresholds and the category probability curves showed a good performance of the Likert scale [26]. Based on the outlined items, the reliability and validity of the instrument can be affirmed, as well as the correct measurement of entrepreneurial ability.

The items of the instrument were correctly distributed along the scale of measurement. However, there is room for improvement, such as finding new items that are homogeneously distributed along the linear scale and eliminating those considered redundant. An item is repetitive when it is horizontally aligned with another item [21], which is easier to visualize in the Wright map. This model makes it possible to answer the questions: Who are the most skilled farmers? Who are the least skilled? Which are the most complex items to implement? Which are the least complex? In which areas should training be provided to improve the entrepreneurial skills?

In terms of the skills of the small-scale farmers, 66.6% showed weaknesses, as they fell below the average skills, which was a lower level of skill than that reported in other research [5,18,19]. In terms of the difficulty of the items, the most complex to put into practice were the support in networking to publicize the productive unit and the product, the formalization of a business, and the use of technologies (ICT) for development of the productive unit. These items, that are difficult to learn in the real world, could be considered in training courses to improve the entrepreneurial skills of small-scale farmers.

5. Conclusions

This research contributes to the gaps in the literature on the entrepreneurial skills of small-scale farmers, which has been little addressed in underdeveloped regions of Mexico. The study provides a methodological contribution by establishing the reliability and validity of the instrument to measure entrepreneurial skills. The results can be used to strengthen these skills through training or nonformal education, as well as to design municipal or regional policies that promote the success of production units and sustainable community development.

The inability to generalize the results to all small-scale farmers is a limitation of this study. Future research should continue to improve the instrument, deepen the entrepreneurial skills that small-scale farmers already exhibit, and work to strengthen those they do not yet possess. It is also appropriate to measure these skills in other regions of the state and the country, making comparisons between regions, between smallholders, between sexes, and taking into account social and economic levels.

Author Contributions: Conceptualization, C.A.C.-R.; methodology, C.A.C.-R., G.M.-G., J.L.R.-L. and E.A.-B.; software, C.A.C.-R. and J.L.R.-L.; validation, G.M.-G. and J.L.R.-L.; formal analysis, C.A.C.-R., G.M.-G., J.L.R.-L. and E.A.-B.; investigation, C.A.C.-R.; resources, G.M.-G.; writing—original draft preparation, C.A.C.-R.; writing—review and editing, G.M.-G.; visualization, J.L.R.-L. and E.A.-B.; supervision, G.M.-G.; project administration, C.A.C.-R. All authors have read and agreed to the published version of the manuscript.

Funding: Thanks to Chapingo Autonomous University—DGIP.

Institutional Review Board Statement: Not applicable.

Data Availability Statement: All data generated or analyzed during this study are included in this published article and are available on request from the first author.

Acknowledgments: The researchers thank the small producers of San Pablo Huixtepec, Oaxaca, Mexico, for participating in this study.

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

References

1. Pindado, E.; Sánchez, M. Researching the entrepreneurial behaviour of new and existing ventures in European agriculture. *Small Bus. Econ.* **2017**, *49*, 421–444. [CrossRef]
2. Phelan, C.; Sharpley, R. Exploring Agritourism Entrepreneurship in the UK. *Tour. Plan. Dev.* **2011**, *8*, 121–136. [CrossRef]
3. Opolot, H.N.; Isubikalu, P.; Obaa, B.B.; Ebanyat, P. Influence of university entrepreneurship training on farmers' competences for improved productivity and market access in Uganda. *Cogent Food Agric.* **2018**, *4*, 1469211. [CrossRef]
4. Bosworth, G.; McElwee, G.; Smith, R. Rural enterprise in Mexico: A case of necessity diversification. *J. Enterp. Communities* **2015**, *9*, 327–343. [CrossRef]
5. Salau, E.S.; Adua, M.M.; Maimako, M.B.; Alanji, J. Entrepreneurship skills of small and medium scale poultry farmers in Central Agricultural Zone of Nasarawa State Nigeria. *J. Agric. Ext.* **2017**, *21*, 126–135. [CrossRef]
6. INEGI. Encuesta Nacional Agropecuaria 2019. Available online: https://www.inegi.org.mx/programas/ena/2019/#:~:text=La%20Encuesta%20Nacional%20Agropecuaria%202019,de%20este%20tipo%2C%20le%20anteceden (accessed on 10 December 2022).
7. Dias, C.S.L.; Rodrigues, R.G.; Ferreira, J.J. Agricultural entrepreneurship: Going back to the basics. *J. Rural Stud.* **2019**, *70*, 125–138. [CrossRef]
8. UN. The 2030 Agenda and the Sustainable Development Goals: An Opportunity for Latin America and the Caribbean. Available online: https://repositorio.cepal.org/handle/11362/40156 (accessed on 15 November 2022).
9. McElwee, G. Farmers as entrepreneurs: Developing competitive skills. *J. Dev. Entrep.* **2006**, *11*, 187–206. [CrossRef]
10. Phelan, C.; Sharpley, R. Exploring entrepreneurial skills and competencies in farm tourism. *Local Econ.* **2012**, *27*, 103–118. [CrossRef]
11. Babu, S.C.; Manvatkar, R.; Kolavalli, S. Strengthening Capacity for Agribusiness Development and Management in Sub-Saharan Africa. *Afr. J. Manag.* **2016**, *2*, 1–30. [CrossRef]
12. Cortés-Rodríguez, C.A.; Martínez-Gómez, G.; Vega-Martínez, D.; Sangerman-Jarquín, D.M. Capacitación para el emprendimiento agrícola: Un análisis bibliométrico. *Rev. Mex. Cienc. Agric.* **2022**, *13*, 1271–1283. [CrossRef]
13. Baum, J.R.; Locke, E.A. The relationship of entrepreneurial traits, skill, and motivation to subsequent venture growth. *J. Appl. Psychol.* **2004**, *89*, 587–598. [CrossRef]

14. Chen, C.C.; Greene, P.G.; Crick, A. Does entrepreneurial self-efficacy distinguish entrepreneurs from managers? *J. Bus. Ventur.* **1998**, *13*, 295–316. [CrossRef]
15. Oosterbeek, H.; van Praag, M.; Ijsselstein, A. The impact of entrepreneurship education on entrepreneurship skills and motivation. *Eur. Econ. Rev.* **2010**, *54*, 442–454. [CrossRef]
16. Rauch, A.; Frese, M. Let's put the person back into entrepreneurship research: A meta-analysis on the relationship between business owners' personality traits, business creation, and success. *Eur. J. Work Organ. Psychol.* **2007**, *16*, 353–385. [CrossRef]
17. Unger, J.M.; Rauch, A.; Frese, M.; Rosenbusch, N. Human capital and entrepreneurial success: A meta-analytical review. *J. Bus. Ventur.* **2011**, *26*, 341–358. [CrossRef]
18. Sher, A.; Mazhar, S.; Abbas, A.; Iqbal, M.; Li, X. Linking Entrepreneurial Skills and Opportunity Recognition with Improved Food Distribution in the Context of the CPEC: A Case of Pakistan. *Sustainability* **2019**, *11*, 1838. [CrossRef]
19. Rosairo, H.S.R.; Potts, D.J. A study on entrepreneurial attitudes of upcountry vegetable farmers in Sri Lanka. *J. Agribus. Dev. Emerg. Econ.* **2016**, *6*, 39–58. [CrossRef]
20. Becot, F.; Conner, D.; Kolodinsky, J. Where do agri-food entrepreneurs learn their job and are there skills they wished they had learned? *Int. J. Entrep. Innov.* **2015**, *16*, 207–215. [CrossRef]
21. Linacre, J.M. A User's Guide to Winsteps-Ministeps Rasch-Model Computer Programs. Available online: https://www.winsteps.com/winman/copyright.htm (accessed on 18 September 2022).
22. Wright, B.D.; Masters, G.N. *Rating Scale Analysis*, 1st ed.; MESA Press: Chicago, IL, USA, 1982; pp. 1–201.
23. Arias-González, V.B.; Crespo-Sierra, M.T.; Arias-Martínez, B.; Martínez-Molina, A.; Ponce, F.P. An in-depth psychometric analysis of the Connor-Davidson Resilience Scale: Calibration with Rasch-Andrich model. *Health Qual. Life Outcomes* **2015**, *13*, 154. [CrossRef] [PubMed]
24. Tennant, A.; Conaghan, P.G. The Rasch measurement model in rheumatology: What is it and why use it? When should it be applied, and what should one look for in a Rasch paper? *Arthritis Rheum.* **2007**, *57*, 1358–1362. [CrossRef] [PubMed]
25. Ambiel, R.A.M.; Noronha, A.P.P.; de Francisco-Carvalho, L. Analysis of the professional choice self-efficacy scale using the Rasch-Andrich rating scale model. *Int. J. Educ. Vocat. Guid.* **2015**, *15*, 205–219. [CrossRef]
26. You, H.S.; Kim, K.; Black, K.; Min, K.W. Assessing Science Motivation for College Students: Validation of the Science Motivation Questionnaire II using the Rasch-Andrich Rating Scale Model. *Eurasia J. Math. Sci. Technol. Educ.* **2018**, *14*, 1161–1173. [CrossRef]
27. Aryadoust, V.; Shahsavar, Z. Validity of the Persian Blog Attitude Questionnaire: An evidence-based approach. *J. Mod. Appl. Stat. Methods* **2016**, *15*, 417–451. [CrossRef]
28. Aryadoust, V.; Mehran, P.; Alizadeh, M. Validating a computer-assisted language learning attitude instrument used in Iranian EFL context: An evidence-based approach. *Comput. Assist. Lang. Learn.* **2016**, *29*, 561–595. [CrossRef]
29. Eakman, A.M. Measurement characteristics of the engagement in meaningful activities survey in an age-diverse sample. *Am. J. Occup. Ther.* **2012**, *66*, 20–29. [CrossRef]
30. Higgins, L.M.; Schroeter, C.; Wright, C. Lighting the flame of entrepreneurship among agribusiness students. *Int. Food Agribusiness Manag. Rev.* **2018**, *21*, 121–132. [CrossRef]
31. Naval, R.C.; Carig, E.T.; Dolojan, F.M.; Julian, B.S.; Ngabit, J.B.A.B. Empowering the entrepreneurial skills of women vegetable growers through farmer business school. *Int. J. Agric. Technol.* **2021**, *17*, 991–1000.
32. Boone, W.J.; Staver, J.R.; Yale, M.S. *Rasch Analysis in the Human Sciences*, 1st ed.; Springer Dordrecht: New York, NY, USA, 2014; pp. 1–478.
33. Boone, W.J. Rasch analysis for instrument development: Why, when, and how? *CBE Life Sci. Educ.* **2016**, *15*, 1–7. [CrossRef] [PubMed]
34. Linacre, J.M. What do infit and outfit, mean-square and standardized mean? *Rasch Meas. Trans.* **2002**, *16*, 878.
35. Linacre, J.M. Category Disordering (disordered categories) vs. Threshold Disordering (disordered thresholds). *Rasch Meas. Trans.* **1999**, *13*, 675.
36. SIAP. Servicio de Información Agroalimentaria y Pesquera: Cierre de la Producción Agrícola. Available online: https://nube.siap.gob.mx/cierreagricola/ (accessed on 10 November 2022).
37. Galloway, A. Non-Probability Sampling. In *Encyclopedia of Social Measurement*, 1st ed.; Kempf-Leonard, K., Ed.; Elsevier: Texas, TX, USA, 2005; pp. 859–864.
38. Winsteps: Multiple Choice, Rating Scale, and Partial Credit Rasch Analysis. Available online: https://www.winsteps.com/winsteps.htm (accessed on 17 July 2022).
39. Wright, B.D.; Linacre, J.M. Reasonable mean-square fit values. *Rasch Meas. Trans.* **1994**, *8*, 370.
40. Sandhu, N.; Hussain, J.; Matlay, H. Entrepreneurship education and training needs of family businesses operating in the agricultural sector of India. *Educ. Train.* **2012**, *54*, 727–743. [CrossRef]
41. Pindado, E.; Sánchez, M.; Verstegen, J.A.A.M.; Lans, T. Searching for the entrepreneurs among new entrants in European Agriculture: The role of human and social capital. *Land Use Policy* **2018**, *77*, 19–30. [CrossRef]
42. Cieslik, K.; D'Aoust, O. Risky Business? Rural Entrepreneurship in Subsistence Markets: Evidence from Burundi. *Eur. J. Dev. Res.* **2018**, *30*, 693–717. [CrossRef]
43. Martinho, V.J.P.D. Agricultural Entrepreneurship in the European Union: Contributions for a Sustainable Development. *Appl. Sci.* **2020**, *10*, 2080. [CrossRef]

44. Landini, F.; Vargas, G.; Bianqui, V.; Mathot y Rebolé, M.I.; Martínez, M. Contributions to group work and to the management of collective processes in extension and rural development. *J. Rural Stud.* **2017**, *56*, 143–155. [CrossRef]
45. Anwarudin, O.; Sumardjo, S.; Satria, A.; Fatchiya, A. Factors influencing the entrepreneurial capacity of young farmers for farmer succession. *IJITEE* **2019**, *9*, 1008–1014. [CrossRef]
46. Arias, V.B.; Gómez, L.E.; Arias, B.; Rodríguez, H.; Silva, N. Evaluación de las habilidades sociales en adultos con discapacidad intelectual: Calibración de la escala SPSS-R mediante el modelo de Rasch. *Psicol. Conductual* **2014**, *22*, 479–500.