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# The Impact of Implementing Support Programs on Equitable Income Distribution Among Buffalo Milk Producers in Iraq

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**Abstract**

This study examined the impact of technologies from the United Nations-supported project "Restoring and Strengthening the Resilience of Food Systems" on the equitable distribution of production and income among milk buffalo owners in Iraq. The Lorenz and Gini indices collected data from 2644 producers in the Maysan, Dhi Qar, and Basra governorates during the 2023-2024 season. The Gini index for milk producers who adopted new technologies was 65.53% compared to 65.70% for those who did not, indicating a more equitable wealth distribution among adopters. The Lorenz curve analysis supports this, showing that technology adopters have wealth distribution closer to equality. Overall, milk producers involved in the project to strengthen food systems exhibited more equitable wealth and production distribution over non-participantraqs. This was confirmed by the t-test comparing the two samples, which showed a significant difference between their income levels, and preference being given to the program participants. The research recommends adopting modern feeding technologies for buffaloes to improve income distribution among milk producers in the area.

**Keywords:** Lorenz curve, Gini coefficient, Milk producers, Income distribution.

# أثر تطبيق برامج الدعم لمنتجي حليب الجاموس على عدالة توزيع الدخول للمربين

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**الخلاصة**

تناول البحث أثر التقنيات التي نفذها مشروع "استعادة وتعزيز قدرة النظم الغذائية على الصمود" المدعوم من الأمم المتحدة في جنوب العراق، على التوزيع العادل للإنتاج والدخل بين مربي الجاموس في العراق، وذلك باستخدام مؤشري لورنز وجيني. جُمعت البيانات من 2644 منتجًا في محافظات ميسان وذي قار والبصرة خلال موسم 2023–2024. بلغ مؤشر جيني لمنتجي الحليب الذين تبنوا تقنيات جديدة 65.53%، مقارنةً بـ 65.70% لأولئك الذين لم يتبنوها، مما يشير إلى توزيع أكثر عدالة للثروة بين المتبنين. ويؤكد تحليل منحنى لورنز هذه النتيجة، موضحًا أن مستخدمي التكنولوجيا يتمتعون بتوزيع أكثر عدالة للثروة. وبشكل عام، يُظهر مربو الألبان المشاركون في مشروع تحسين النظم الغذائية مستويات دخل أعلى من غير المشاركين. لذا، توصي الدراسة بتبني تقنيات حديثة لتغذية الجاموس لتحسين توزيع الدخل بين مربي الألبان في المنطقة.

**كلمات مفتاحية:** التكنلوجيا، منحنى لورنز، معامل جيني، منتجو الحليب، توزيع الدخل.

## Introduction

Income distribution is defined as how income and national wealth are distributed among individuals and groups in society under a particular framework of values, traditions, and civilizational aspirations of society. In simple terms, it can be defined within the framework of the capitalist economy as the distribution of output in the form of money or prices among participants from the production of a project (5 and 15). Income distribution includes wealth distribution, with inequality considered a deviation from an equal or equitable distribution. It may be economic, such as disparities in the distribution of income or wealth, and in the standard of living or society, such as disparity in health care or education (1). It may be related to inequality in outcomes or equal opportunities.

Meanwhile, measuring inequality is intended to transform measures of dispersion into measures of inequality. The definition of income distribution inequality in this sense, i.e., based on complete equality or the personal distribution of income only, excludes justice in its objective sense. Field and laboratory studies show that people prefer fair over equal distribution (11). Economic inequality can be divided into exponential and consensual levels, with the former referring to treating different economic centers differently, and the latter to treating similar economic centers with similar economic treatment.

Some believe that the measurement of inequality or inequity in income distribution is based on economic theory, linking the theory of distribution to measure the extent of fairness in the initial income distribution among the participants in the production process. The theory of distributive justice measures the extent of fairness in the distribution of transfers among members of society. Since the recipients of primary income differ from the recipients of cash, non-cash, and service transfers, an accurate measure of the fairness of income distribution requires taking the relative weight of each of the size of the two communities and that of their income into account. It is noted that the classics have delved into the phenomenon of income distribution between groups or social classes that contribute to the production process. At the same time, neoclassicism has focused on the distribution of income between the elements of production, while modern economists have been interested in the distribution of income between individuals and families. This ignores the main dimensions of income distribution among participants in the production process, as well as the distribution of income between groups and social classes (capital and labor) (9). Various researchers have addressed this topic, including (2 and 3).

This research explores the importance of buffalo products in the marsh areas as a significant food source for all southern regions, in addition to the importance of programs targeting the marsh region for economic, social, and environmental development. It also examines the importance of the technology used (molasses) in increasing the production of buffalo milk. Molasses (or sugar juice) is a by-product of the sugar industry from sugar cane or sugar beet containing dissolved sugars (sucrose, fructose, and glucose), and is used in ruminant feed to improve its nutritional value as a feed additive, liquid nutrients or molasses mineral briquettes. The research problem highlights the imbalance and inequality in the distribution of income for buffalo owners producing milk in the marsh areas of southern Iraq. This is due to the variations in the quantities of milk produced as one of the main sources of income in the region, which negatively affects the standard of living of the buffalo owners there.

The research assumes that the Restoring and Strengthening the Resilience of Food Systems in Southern Iraq project among participating buffalo milk producers in the three governorates of Maysan, Thi-Qar and Basra led to more equitable and optimal income distribution among them. The research aimed to identify and measure income inequality using the Lawrence and Gini scales for 2644 buffalo owners compared to non-subsidized owners for the 2023-24 production season using FAO data (4). The project is part of the EU Action Document to Support Government and Create Sustainable Jobs in Iraq. Several international partners (FAO, ILO, IOM, ITC, and UNESCO) are collaborating to implement the Food Business Development Programme. The program’s objectives include providing employment opportunities for the rural poor, achieving more resilient food systems, enabling smallholders and landless to improve productivity and generate income in priority value chains for vegetables, buffaloes and dates while enhancing land, water and biodiversity resources.

The program involves several main pillars:

- Improving the enabling environment by participating in policies and legislative changes that will facilitate economic reforms and improve working conditions.
- Building the capacity of public and private sector actors and service providers.
- Supporting smallholder farmers in adopting sustainable practices through training and technology.
- Promoting MSMEs through the provision of technical and financial support.
- Promoting agribusiness development and networking linkages.
- Improving the management of natural resources, especially water and biodiversity, at the farm level.

## Materials and Methods

Measures of inequality in income distribution:
Income distribution inequality can be measured using the following (4):

1. Ordinal distribution of income, the most important being Lawrence's order, which can be obtained by dividing the cumulative (aggregate) function of the income distribution by the average income function.
2. System income distribution method (Gini coefficient).

Economists and statisticians interested in income distribution, variation, and the share of enterprises in the total market have developed measures to determine income distribution or the extent to which market shares in production or sales is concentrated among specific groups of producers or sellers. These measures are limited to three: the Lorenz curve , the Gini coefficient, and the concentration ratio (used in the field of industrial organization) (2). The Gini coefficient and the Lorenz curve are globally-acknowledged statistical means for determining economic distribution issues (2 and 3).

Lorenz Curve: This scale was developed by the Austrian scientist Konrad Lorenz in 1950 and is among the main ways to express inequality in income distribution. It depicts income disparities by the gap between the absolute equality line and the actual distribution curve. It measures inequality in the distribution of household incomes, and shows the relationship between the relative accumulation of families or individuals and their income. The cumulative upward frequency of percentages of total incomes realized within these categories is shown in Figure 1. The drawing from the lower left to the upper right corner represents the line of perfect equality. Along this line each economic unit receives an equal share of income, and as no society has complete income equality the Lorenz curve does not touch this line except at the beginning and the end (12).

Gini Coefficient: This coefficient is among the most important indicators for measuring disparities in distribution due to the clarity of its idea and ease of calculation. This scale is attributable to the Italian statistician and sociologist Corrado Jenny in 1912, and it calculated by dividing the area between the Lorenz curve and the equality line by the total area below the perfect equality line. The value of this coefficient is between zero (absolute equality in income distribution) and one (absolute disparity in income distribution). The closer the Gini coefficient is to zero, the fairer the income distribution, and vice versa. The formula for its calculation is as follows (13):

$$Gin = 1 - \frac{1}{10000}\sum_{i=1}^{n}(S_i + S_{i-1})W_i$$

where:

Gin: Gini coefficient.

Si: Ascending aggregated frequency of category (i) spending percentages.

Si-1: Ascending cumulative frequency of pre-class income percentages for class (i).

Wi: Percentage of individuals in category (i).

The coefficient ranges between 0.5 and 0.7 in countries having significant income or expenditure distribution disparities, and between 0.2 and 0.35 where there is greater equity (10).

The Gini coefficient is a statistical value that does not rely on a particular statistical distribution or economic theory, making it difficult to perform statistical tests (hypothesis tests and confidence intervals) (8 and 14). Some studies argue that it reflects broader considerations related to social welfare, with (6) suggesting that it is not merely an economic measure but incorporates value judgments on the significance of inequality at various points on the Lorenz curve.

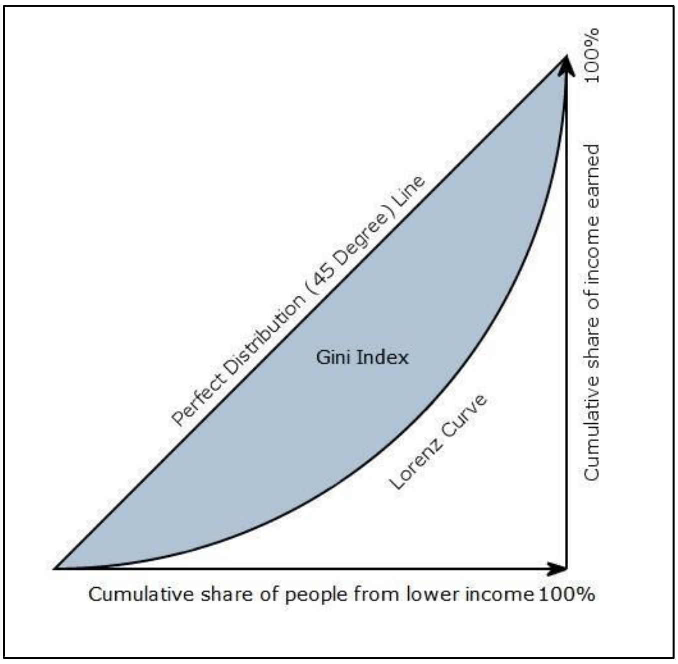


**Figure 1: Gini coefficient and Lorenz curve.**

Source: Piketty, 2016, 44.

## Results and Discussion

T-test comparing average incomes of buffalo owners in and outside the program: To determine whether there were differences between the average incomes of adopters and non-adopters, a t-test was conducted for the samples on the null and alternative hypotheses.

After the selection process (Table 1), the t parameter value was significantly below the 0.01 level for the comparison between the two samples (the income levels of adopters and non-adopters). This means rejecting the null hypothesis and accepting the alternative hypothesis, which states that the average incomes of adopters differ from those of non-adopters. This is in favor of adopters, as their average incomes are higher than those of non-adopters.

**Table 1: T-test comparing average incomes of program adopters and non-adopters.**

**Group Statistics**

| | ca | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| y | 1 | 1322 | 21656.74 | 34237.759 | 941.650 |
| | 2 | 1322 | 29392.02 | 40632.307 | 1117.521 |

**Independent Samples Test**

| | | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | t-test for Equality of Means | | | | | | | | |
| | | | | | | | | | Lower | Upper |
| y | Equal variances assumed | 21.361 | .000 | 5.293 | 2642 | .000 | 7735.276 | 1461.355 | 10600.7 | 4869.76 |
| | Equal variances not assumed | | | 5.293 | 2568.147 | .000 | 7735.276 | 1461.355 | 10600.83 | 4869.722 |

Source: SPSS analysis based on the sample data.

Estimation of Lorenz and Gini coefficients: One of the most important and common measures on income distribution is the Lorenz curve. The Gini coefficient is characterized by a numerical measurement of the fairness of the distribution. It calculates the area between the Lorenz curve and the equality line (the line of symmetry), the diagonal line connecting the origin and the point [1,1] in the graph, and multiplying it by 2. This is because the area of the triangle between the equal line and the horizontal and vertical coordinates is equal to 0.5. As such, the Gini coefficient lies between zero (perfectly equal income distribution) and one (perfect inequality in income distribution (7).

To derive the Lorenz curve in Excel, five categories were prepared for the number of buffaloes owned. The categories are placed in ascending order with the corresponding number of producers and production volume in tons. The curve passes through two stages. The first stage extracts the percentage of the producers and their production outputs, while the second stage calculates the cumulative upward frequency of the producers (x-axis) and the ascending cumulative frequency of revenue (y-axis).

Table 2 shows the categories and frequencies of milk producers in the three governorates that do not use the techniques. It provides details of milk producers not using the technologies and shows that the first category accounted for 79% of the total and indicates that herd sizes are small in the three governorates. The 1048 owners combined contributed 41% of the total amount of milk production. The second category comprised 190 or 14% of the total number of producers contributing 32% of total milk production. The third category comprised 56 owners or 4% of the total and their production amounted to 12% of the total. The fourth and fifth categories constituted about 1% of the sample with 14 owners each. The fourth category was the least productive with only 5% of total production while the fifth category's production amounted to 8% of the total.

**Table 2: Lawrence curve data for non-program milk producers.**

| Category | No. of producers | % | Output without molasses (Letter) | Production (%) | Cumulative upward frequency of producers | Cumulative upward frequency of revenue |
|---|---|---|---|---|---|---|
| **1-15** | 1048 | 79.27 | 10169.2 | 41.27 | 0 | 0 |
| **16-30** | 190 | 14.37 | 7988.4 | 32.42 | 79.27 | 41.27 |
| **31-45** | 56 | 4.24 | 3056.6 | 12.41 | 93.65 | 73.69 |
| **46-60** | 14 | 1.06 | 1449.4 | 5.88 | 97.88 | 86.10 |
| **>60** | 14 | 1.06 | 1976.3 | 8.02 | 98.94 | 91.98 |
| **Total** | 1322 | 100.00 | 24639.9 | 100.00 | 100.00 | 100.00 |

Source: Calculated using Microsoft Excel based on sample data.

Based on the data in Table 2, the Lorenz curve is generated as shown in Figure 2.

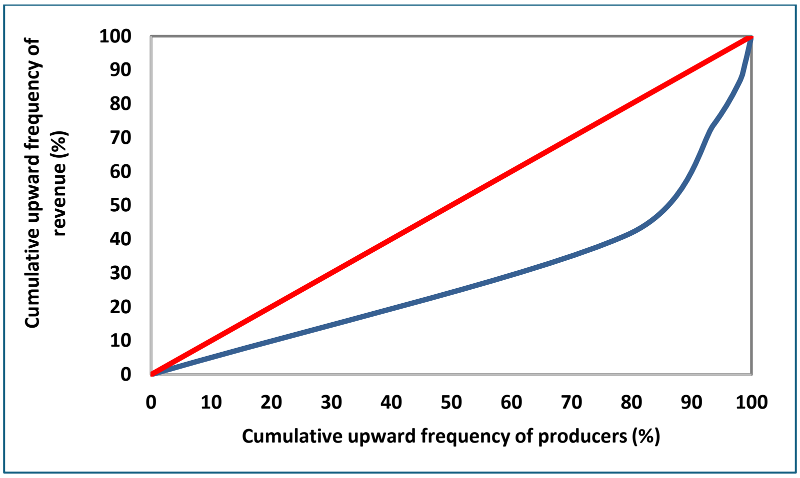


**Figure 2: Lawrence curve for non-program milk producers.**

Source: Microsoft Excel graph based on sample data.

The Gini coefficient was calculated based on data from Table 3.

**Table 3: Gini coefficient for non-technology using producers.**

| si | Si-1 | wi | (Si+Si-1)*wi |
|---|---|---|---|
| 0 | 0 | 5 | 0 |
| 41.27127 | 0 | 5 | 206.356357 |
| 73.69186 | 41.27127 | 5 | 574.815645 |
| 86.09694 | 73.69186 | 5 | 798.943989 |
| 91.97927 | 86.09694 | 5 | 890.381049 |
| 100 | 91.97927 | 5 | 959.896347 |
| Total | | | 3430.39339 |

Source: Sample data using Microsoft Excel.

Substituting in the formula,

$$G = \{1 - (3430.39/10000)\} * 100$$

the Gini coefficient for non-technology-adopting milk producers was thus 65.70%.

For the milk producers who adopted technologies, the Lorenz curve was based on data from five categories. It included number of buffaloes owned, the number of producers, and their production revenue for the 2023-24 agricultural season (Table 4).

**Table 4: Lawrence curve data for milk producers in the program.**

| Category | No. of producers | % | Output with Molasses (Letter) | Production % | Cumulative upward frequency of producers | Cumulative upward frequency of revenue |
|---|---|---|---|---|---|---|
| **1-15** | 1048 | 79.27 | 13266 | 42.68 | 0 | 0 |
| **16-30** | 190 | 14.37 | 9734 | 31.31 | 79.27 | 42.68 |
| **31-45** | 56 | 4.24 | 3859 | 12.41 | 93.65 | 73.99 |
| **46-60** | 14 | 1.06 | 1615 | 5.20 | 97.88 | 86.41 |
| **>60** | 14 | 1.06 | 2611 | 8.40 | 98.94 | 91.60 |
| **Total** | 1322 | 100.00 | 31085 | 100.00 | 100.00 | 100.00 |

Source: Microsoft Excel graph based on sample data.

The Lorenz curve in Figure 3 is derived based on the data in Table 3.

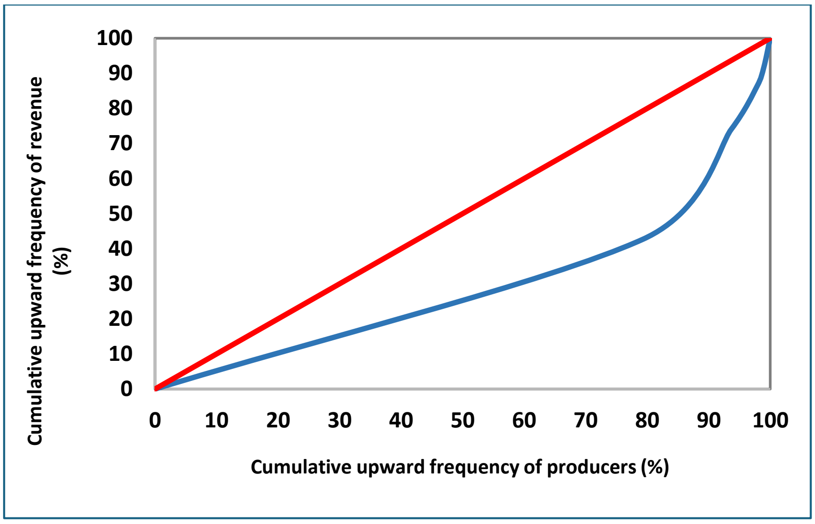


**Figure 3: Lorenz curve for milk producers in the program.**
Source: Microsoft Excel graph based on sample data.

The Gini coefficient was calculated based on the data from Table 4.

**Table 5: Gini coefficient for milk producers in the program.**

| Si | Si-1 | wi | (si+si-1) *wi |
|---|---|---|---|
| **0** | 0 | 5 | 0 |
| **42.67653** | 0 | 5 | 213.38266 |
| **73.99067** | 42.67653 | 5 | 583.336014 |
| **86.40502** | 73.99067 | 5 | 801.978446 |
| **91.60045** | 86.40502 | 5 | 890.027344 |
| **100** | 91.60045 | 5 | 958.002252 |
| **Total** | | | 3446.72672 |

Source: Sample data using Microsoft Excel.

Substituting in the formula,

$$G = \{1 - (3446.72/10000)\} \times 100$$

the Gini coefficient for the technology-using milk producers was thus 65.53%.

The Lorenz curves in Figures 2 and 3 of the study population (adoptive and non-adopter) show that the program-technology adopters are closer to symmetry with the approach of the curve to the line of equal distribution. This indicates that the adoption of technology by the milk producers contributed towards improving revenue distribution among them as seen in the lower Gini coefficient of 65.53% compared to the 65.70% among the non-adopters. This means that the technology adopters had less income distribution disparity. Thus, the position on the line of symmetry on the Lorenz curve is a good indicator of wealth distribution based on whether technology is or isn't adopted.

## Conclusions

Based on the results, and although they were similar, it can be concluded that technology users enjoyed a more equitable distribution of wealth and production compared to non-users. This similarity can be explained by the Gini coefficient, indicating that the support program provided assistance to breeders in a specific area—namely, improving animal nutrition with a single type of feed. Furthermore, most breeders do not rely solely on buffalo breeding for their livelihood but have other sources of income, thus supporting the research hypothesis. A clear disparity in income and wealth distribution was observed among different segments of society. Therefore, the research recommends supporting small-scale milk producers to ensure their continued production and providing buffalo owners with broader access to modern technologies to enhance production. This will also contribute to greater equality in income and wealth distribution among them.

**Supplementary Materials:**

No Supplementary Materials.

**Author Contributions:**

Mowj M. N: methodology, writing—original draft preparation; Osamah K. J. and Mohammed J. A.: writing—review and editing. All authors have read and agreed to the published version of the manuscript.

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**Informed Consent Statement:**

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**Data Availability Statement:**

Data available upon request.

**Conflicts of Interest:**

The authors declare no conflict of interest.

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