**Profitability Analysis of Mentha Growers in Ambedkar Nagar District of Uttar Pradesh, India**

**Abstract**:

 In the present paper, an attempt has been made to examine Mentha production in different categories of the farmers entitled Profitability Analysis of Mentha Growers in Ambedkar Nagar District of Uttar Pradesh. Hundred sample farmers (marginal 48, Small 31, & medium 21) where interviewed form 5 villages of Baskhari block in Ambedkar Nagar district. Data was analysis and found that Average holding Size is 1.17 ha. Cropping intensity of sample farms was to 201.64 percent which was found highest on marginal farms 226.09 percent followed by Small 214.17 percent and medium 190.99 percent respectively. On an Average cost of cultivation was rupees 46806.70 per/ha. The gross & net income of overall farms where found to be rupees 141208.80 and 94402.10 per ha respectively. The input and output ratio was found to be 1:3.12 On cost C3 the study was characterized by decreasing return to scale.

***Keywords:*** *farm structure, cropping pattern, cropping intensity and cost& returns etc.*

**INTRODUCTION:**

Mentha a plant with both medical and aromatic properties, is part of an important group of plants that provide vital raw ingredients for common items like tastes, fragrances, and medications. These plants and their derivatives are important sources of revenue for small-scale farmers and business owners, and they also help countries earn foreign cash through exports. India is thought to be the natural habitat of aromatic and medicinal plants, hosting a vast array of plant species due to its unique soil and climate [9,10]. These plants are becoming more and more well-known around the world due to their unrealized economic potential, especially in the area of herbal remedies (Kumar *et al.,* 2024).

India holds the largest share of the global Mentha oil market, followed by China, Brazil, the United States, and Japan. India produces nearly 80 percent of the world’s Mentha oil, with global production estimated at around 48,500-50,000 tonnes (MCX, 2021). Indian production alone ranged between 30,000 and 40,000 tonnes in 2020-2022. Besides India, China contributes about 9 percent, Brazil 7 percent, and the USA 4 percent to global Mentha oil production. The demand for Mentha oil is increasing both domestically and internationally, in countries such as the European Union, the United Kingdom, Japan, China, Singapore, and Germany (Pal *et al.,* 2016). Although the price of Mentha oil has fluctuated over the past decade, During the Covid-19 pandemic, there has been a worldwide increase in demand for natural and organic immune-boosting products, leading to a growing market for mint essential oil and its crystal form. Additionally, the rising demand for fresh and nutritious foods, beverages, and cosmetics creates a substantial market opportunity for leading competitors in the mint essential oils market. (Grand View Research, California, 2019).

There is a significant and growing market for natural medications. Roughly 500 plants have been used medicinally in ancient texts, and about 800 species have been used in traditional medical systems. The long-term health advantages, affordability, simplicity of use, and environmental friendliness of traditional medicines made from these plants are highly prized.

Uttar Pradesh stands as the largest producer of Mentha, contributing approximately 82percent of the total Mentha production in the country. The state cultivates Mentha across an area of around 215 thousand hectares, yielding an annual production ranging from 26,000 to 28,000 tonnes (Singh and Sharma 2011).The Barabanki, Rampur, Moradabad, Ambedkar Nagar Bijnor, Badaun, Pilibhit, Bareilly, Shahjahanpur, Hardoi, Unnao, Faizabad, Badaun, Lucknow, and Sultanpur are among the major Mentha-producing districts in Uttar Pradesh. Barabanki is well- known for being the world’s Mentha- growing region. The Barabanki district only produces approximately 65-70 percent of Uttar Pradesh's total menthe production**.**

Keeping this in view the proposed study entitled “**Profitability Analysis of Mentha Growers in Ambedkar Nagar District of Uttar Pradesh”** assumes special significance. The main objectives of studied were.

1. To study the farm structure, cropping pattern and cropping intensity on different size of sample Farms.
2. To work out the cost of cultivation and different profit measures on different size of sample farms.

**Materials and Methods**

1. **Sampling Technique:** Multi stage stratified purposive cam random sampling techniques were applied for selection of respondents to deal with the investigation.
2. **Selection of District:** In view of limited time and knowledge of the researcher with Ambedkar Nagar district was selected purposively.
3. **Selection of Block:** One at first, a list of all 9 blocks of Ambedkar Nagar district of Uttar Pradesh along with acreage of Mentha cultivation were prepared and arranged in descending order. The block namely “baskhari” having highest area in field Mentha was selected purposively for this study.
4. **Selection of Village:** A list of all the villages falling under Baskhari block was prepared, arranged in ascending order to the area covered under Mentha crop and five villages were selected randomly from this list.
5. **Selection of Respondents:** A separate list of all respondent growing Mentha of each selected village was prepared. All Mentha grower selected village was stratified into three categories. i.e. Marginal (less than1 ha.), Small (1-2ha.) and Medium(2-4ha. And above)

From this list a sample of 100 respondents was drawn following the proportionate random sampling technique categories.

**Collection of Data:** The primary data was collected through survey method with the help of personal interview of pre-structured schedule while secondary data collected from Zila Vikas Bhawan, Zila Sankhyaki Patrika, Department of Agriculture at block and district head quarter, journal reports, books and internet etc. A list of all the villages falling under select block was prepared and arrange in ascending order according to area and five villages from Baskhari block was randomly selected for the study.

**Period of study:** The data was collected for the agriculture year 2022-23.

2. **Method of enquiry:** For the interpretation of data the following analytical tools were used:

Tabular Analysis: Tabular analysis was made to compare different aspects of analysis of costs and returns on different categories of the sample farms.

(ii) Average: The simplest and the most important measures of average mean and weighted mean were applied. The formula of mean and W.A. is given below:



Where,

 X= Value of variable

 N= Number of observation

 $W.A.=\frac{∑Wi Xi}{∑Wi}$

Where,

 W.A. = Weighted Average

Wi = Weight of Xi

 Xi = Variable

(b) Percentage = Simple comparisons have been made on the basis of percentage.

(iii) **Measures of Cost Concepts:**

Cost A1 = this gives the total cash expenses incurred by the grower. It includes the following items (Agarwal *et al.,* 2018).

Cost of hired labour

Cost of bullock labour and tractor charges

Cost of planting materials

Cost of manures, fertilizers and plant protection chemicals Irrigation charges

Interest on working capital

Land revenue

Depreciation on fixed capital

Cost A2 = Cost A1 + rent paid for leased land

Cost B1 = Cost A2 + interest on fixed capital + rental value of owned capital assets (Excluding Land)

Cost B2 =Cost B1 + Rental Value of owned land (Net land Revenue)

Cost C1 = Cost B1+ imputed value of family labour

Cost C2 = Cost B2 + imputed value of family labour

Cost C3 = Cost C2 + 10 per cent of the managerial cost

(iv) Measures of Farm Profit:

Gross Income = Yield in quintal × Price per quintal

Net Income = Gross Income – Cost C

Farm Business Income = Gross Income - Cost A2

or

 Net Income + imputed value of family labour

Family labour income = Gross Income-Cost C

Farm investment income = Net Income + Rental value of owned land

 + Interest on fixed capital

Benefit-cost ratio = Cost C / Gross Income

**Result and discussion:**

**Land Holdings:**

The typical land areas for marginal, small, and medium farms were found to be 0.69,1.27, and 2.11 hectares, respectively. All sampled farms across these categories showed cultivation in irrigated conditions. On average, the size of land holdings was calculated to be 1.17 hectares with irrigated areas covering 100.00 percent. Hence, it can be concluded that the majority of the sampled farms primarily owned irrigated land.

**Table1 Average size of holding under different size group of sample farms(ha)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S.N.** | **Size of farms** | **No. of Farmers** | **Gross Cultivated area(ha)** | **Average size of holdings** |
| 1. | Marginal | 48 | 33.28 (24.92) | 0.69 |
| 2. | Small | 31 | 39.24 (36.97) | 1.27 |
| 3. | Medium | 21 | 44.36 (38.11) | 2.11 |
|  | Total | 100.00 | 116.88 (100.00) | 1.17\* |

\*Indicate overall average (Note: Figures in parentheses indicate percentage of total.)

**Cropping Pattern:**

The cropping pattern demonstrates how cultivated areas are allocated to different crops over a specified period, usually a year. The information presented in Table 2 shows that, on average, the highest percentage of cultivated land on the surveyed farms was allocated to paddy(16.89%),followedbywheat(13.11%),Mentha(21.72%),andmoong(3.28%).

**Table2: Cropping pattern under different size group of farms (area in ha)**

|  |  |  |  |
| --- | --- | --- | --- |
| **S.N.** | **Crops** | **Average Size/of sample farms** | **Overall/average** |
|  |  | **Marginal** | **Small** | **Medium** |  |
| **A.** | **Kharif** |
| 1. | **Paddy** | 0.29(18.59) | 0.5(18.38) | 0.56(13.90) | 0.41(16.89) |
| 2. | **Maize** | 0.12(7.69) | 0.19(6.99) | 0.28(6.95) | 0.18(7.19) |
| 3. | **Pigeonpea** | 0.02(1.28) | 0.06(2.21) | 0.21(5.21) | 0.07(2.97) |
| 4. | **Bajra** | 0.06(3.85) | 0.07(2.57) | 0.19(4.71) | 0.09(3.71) |
|  | **Total** | 0.49(31.41) | 0.82(30.15) | 1.24(30.77) | 0.75(30.75) |
| **B.** | **Rabi** |
| 1. | **Wheat** | 0.21(13.46) | 0.39(14.34) | 0.46(11.41) | 0.32(13.11) |
| 2. | **Pea** | 0.04(2.56) | 0.07(2.57) | 0.24(5.96) | 0.09(3.69) |
| 3. | **Gram** | 0.03(1.92) | 0.02(0.74) | 0.12(2.98) | 0.05(2.05) |
| 4. | **Mentha** | 0.07(4.49) | 0.16(5.88) | 0.16(3.97) | 0.12(4.92) |
| 5. | **Potato** | 0.18(11.54) | 0.37(13.6) | 0.42(10.42) | 0.29(11.89) |
|  | **Total** | 0.53(33.97) | 1.01(37.13) | 1.4(34.74) | 0.86(35.25) |
| **C.** | **Zaid** |
| 1. | **Urd** | 0.09(5.77) | 0.15(5.51) | 0.33(8.19) | 0.16(6.56) |
| 2. | **Moong** | 0.03(1.92) | 0.06(2.21) | 0.2(4.96) | 0.08(3.28) |
| 3. | **Mentha** | 0.37(23.72) | 0.62(22.79) | 0.74(18.36) | 0.53(21.72) |
| 4. | **Vegetables** | 0.05(3.21) | 0.06(2.21) | 0.12(2.98) | 0.07(2.87) |
|  | **Total** | 0.54(34.62) | 0.89(32.72) | 1.39(34.49) | 0.83(34.02) |
|  | **Gross croppedarea(ha)** | 1.56(100.00 | 2.72(100.00) | 4.03(100.00) | 2.44(100.00) |

**Cropping intensity:**

Table 3 presents the cropping intensity among various farm size categories. Marginal farms showed the highest cropping intensity at (226.09)%, followed by small farms at(214.17)%,and medium farms at(190.99)%,respectively. The average cropping intensity across the sampled farms was determined to be (208.55)%. A noticeable inverse correlation between cropping intensity and farm size group was evident.

**Table3 Cropping intensity on different size group of sample farms.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **S.N.** | **Size of farms** | **Farms** | **Net Cultivated area/****(ha)** | **Gross cultivated****area(ha)** | **Cropping****intensity** |
| **1.** | **Marginal** | 48 | 0.69 | 1.56 | 226.09 |
| **2.** | **Small** | 31 | 1.27 | 2.72 | 214.17 |
| **3.** | **Medium** | 21 | 2.11 | 4.03 | 190.99 |
|  | **Total/overall****Average** | 100 | 1.17 | 2.44 | 208.55\* |

\*Indicate overall average percentage of cropping Intensity.

**Per farm investment:**

Table 4. displays the asset distribution per farm among the sampled farms. The data reveals that the primary components of the farm asset structure include farm buildings, tool sand livestock, and machinery. On average, these elements accounted for 62.44%, 5.99%, and31.57% of the total asset value, respectively.

The average values per farm for buildings, machinery, and cattle were Rs.303908.1, Rs. 29161.17, and Rs. 153636.4, respectively, summing up to an average investment of Rs. 486705.6 per farm. Marginal farms received the lowest investment (Rs. 263140.59),while small farms received the highest (Rs. 582195.44), followed By Medium Farms (Rs.856750.2). The investment per farm/in farm assets varied, but consistently displayed positive correlation with harvest size.

**Table 4. Per farm investment on different size Group of farms in the study area.**

|  |  |  |
| --- | --- | --- |
| **S.N.** | **Particular** | **Size of farms** |
|  | **Marginal** | **Small.** | **Medium** | **Overall/average** |
| **1** | **Buildings** | 172983.1(65.74) | 390632(67.10) | 475144(55.46) | 303908.1(62.44) |
| **I** | **Residential** | 157132.1(59.71) | 365436(62.77) | 432472(50.48) | 279527.7(57.43) |
| **A** | **Kachcha** | 8642(3.28) | 1223(0.21) | 0(0.00) | 4527.29(56.50) |
| **B** | **Pacca** | 148490.1(56.43) | 364213(62.56) | 432472(50.48) | 275000.4(5.01) |
| **II** | **Cattle shed** | 15851(6.02) | 25196(4.33) | 42672(4.98) | 24380.36(2.35) |
| **A** | **Kachcha** | 12231(4.65) | 8236(1.41) | 14236(1.66) | 11413.6(2.66) |
| **B** | **Pacca** | 3620(1.38) | 16960(2.91) | 28436(3.32) | 12966.76(5.99) |
| **2** | **Livestock** | 27124(10.31) | 26229(4.51) | 38145.99(4.45) | 29161.17(5.99) |
| **I** | **Mulchanimals** | 27124(10.31) | 26229(4.51) | 38145.99(4.45) | 29161.17(2.32) |
| **A** | **Cow** | 10702(4.07) | 18604(3.2) | 1874.33(0.22) | 11297.81(3.04) |
| **B** | **Buffalo** | 13210(5.02) | 2642(0.45) | 36271.66(0.22) | 14776.87(0.63) |
| **C** | **Goat** | 3212(1.22) | 4983(0.86) | 0(4.23) | 3086.49(31.57) |
| **3** | **Machine&****Implements** | 63033.49(23.95) | 165334.44(28.40) | 343460.21(40.09) | 153636.4(31.57) |
| **I** | **MinorImplement** | 1416.36(0.54) | 2621.34(0.45) | 3324.21(0.39) | 2190.55(0.45) |
| **II** | **MajorImplement** | 61617.13(23.42) | 162713.1(27.95) | 340136(39.70) | 151445.8(31.12) |
|  | **GrandTotal** | 263140.59(100.00) | 582195.44(100.00) | 856750.2(100.00) | 486705.6(100.00) |

\*Figures in parenthesis show the percentage of total cost for each size sample broken down by farm.

**Per/hectare investment on different size group of farms:**

Table 5 shows the investment on a per hectare basis for a range of farm sizes. Overall, the average per hectare investment was determined to be Rs. 410434, with marginal farms recording the highest amount at Rs.262976.4, small farms following at Rs.118389.9, and medium farms at Rs.4009.64. Buildings, machinery & implements, and livestock made up the majority of the farm's structure, accounting for 64.07%, 28.85%, and 7.08 %, respectively.

**Table 5 Per hectare investment on different size group of/ sample farms. (Rs.)**

|  |  |  |  |
| --- | --- | --- | --- |
| **S.N.** | **Particular** | **Sizeof/farms** | **Overallaverage** |
| **Marginal** | **Small** | **Medium** |
| **1.** | **Buildings** | 250700.1(65.74) | 307584.25(67.1) | 225186.73(55.46) | 262976.4(64.07) |
| **A.** | **Residential** | 227727.7(59.71) | 287744.88(62.77) | 204963.033(50.48) | 241552.4(58.85) |
| **a)** | **Kacha** | 12524.64(3.28) | 962.99(0.21) | 0(0.00) | 6310.35(1.54) |
| **B** | **Pacca** | 215203(56.43) | 286781.89(62.56) | 204963.03(50.48) | 235242.1(57.32) |
| **II** | **Cattle shed** | 22972.46(6.02) | 19839.37(4.33) | 20223.70(4.98) | 21423.96(5.22) |
| **A** | **Kacha** | 17726.09(4.65) | 6485.04(1.41) | 6746.92(1.66) | 11935.74(2.91) |
| **B** | **Pacca** | 5246.38(1.38) | 13354.33(2.91) | 13476.78(3.32) | 9488.23(2.31) |
| **2** | **Livestock** | 39310.14(10.31) | 20652.75(4.51) | 18078.67(4.45) | 29067.74(7.08) |
| **I** | **Mulchanimals** | 39310.14(10.31) | 20652.75(4.51) | 18078.67(4.45) | 29067.74(7.08) |
| **A** | **Cow** | 15510.14(4.07) | 14648.82(3.2) | 888.31(0.22) | 12172.55(2.97) |
| **B** | **Buffalo** | 19144.93(5.02) | 2080.31(0.45) | 17190.36(0.23) | 13444.44(3.28) |
| **C** | **Goat** | 4655.07(1.22) | 3923.62(0.86) | 0(0.00) | 3450.76(0.84) |
| **3** | **Machine&****Implements** | 91352.88(23.95) | 130184.60(28.4) | 162777.35(40.09) | 118389.9(28.85) |
| **I** | **MinorImplements** | 2052.7(0.54) | 2064.05(0.45) | 1575.45(0.39) | 1955.99(0.48) |
| **II** | **MajorImplements** | 89300.19(23.42) | 128120.55(27.95) | 161201.90(39.7) | 116433.9(28.37) |
|  | **GrandTotal** | 381363.2(100.00) | 458421.61(100.00) | 406042.75(100.00) | 410434(100.00) |

**Structure of/ cost and income:**

This part of/the findings offers a summary of both expenditure and earnings. It outlines the projected total costs and includes calculations based on six distinct cost categories: A1/A2, B1,B2,C1,C2,andC3. Additionally, it identifies several indicators used to assess the profitability of Mentha cultivation. These indicators include net profit, income from family labor, returns on farm investments, farm revenue, input-output ratio, and efficiency in resource utilization.

**Per/hectare costs of/ cultivation of Mentha:**

Table 6. indicates that medium-sized farms incurred the highest cultivation expenses(Rs.56890.84),followed by small farms (Rs.74833.63) and marginal farms (Rs.41731.65). The average cultivation costs across the sampled farms (Rs. 46806.7) suggest a direct relationship between farm size and expenditure. Human labor accounted for 19.54% of/ the total cultivation costs, with land rental at23.50%, irrigation charges at 10.08%, and other expenses as follows: manure and fertilizer at [missing percentage], tractor labor at6.13%, and interest on fixed capital at1.51%. Family labor exhibited a negative correlation with farm size, whereas hired labor, machinery labor, seed, manure, fertilizer, and irrigation showed positive associations with farm size.

**Table 6. Costs of/ cultivation of/ Mentha crop on different size group of sample farms.**

|  |  |  |
| --- | --- | --- |
| **S.N.** | **Particulars** | **Sizeoffarms (ha)** |
| **Marginal** | **Small** | **Medium** | **Overallaverage** |
| **1.** | **Human Labour** | 7721.45(18.5) | 8538.35(17.85) | 13299.02(23.38) | 9145.98(19.54) |
| **a.** | **Family Labour** | 6814.81(16.33) | 1177.23(2.46) | 664.24(1.17) | 3775.54(8.07) |
| **b.** | **Hired Labour** | 906.64(2.17) | 7361.12(15.39) | 12634.78(1.17) | 5370.44(8.07) |
| **2.** | **Tractor charges** | 2531.02(6.06) | 3064.77(6.41) | 3342.96(5.88) | 2866.99(6.13) |
| **3.** | **Seed** | 3062.12(7.34) | 4231(8.85) | 4632.21(8.14) | 3754.19(8.02) |
| **4.** | **Manures &Fertilizers** | 6945(16.64) | 7984(16.69) | 9642(16.95) | 7833.46(16.74) |
| **5.** | **Irrigation** | 4282.06(10.26) | 4980(10.41) | 5326.02(9.36) | 4717.65(10.08) |
| **6.** | **Plant Protection** | 1324(3.17) | 2369(4.95) | 2980(5.24) | 1995.71(4.26) |
| **7.** | **Total Working Capital** | 19050.84(45.65) | 29989.89(62.70) | 38557.97(67.78) | 26538.44(56.70) |
| **8.** | **Interest on working capital** | 381.0168(0.91) | 599.7978(1.25) | 771.1594(1.36) | 530.77(1.13) |
| **9.** | **Rental/ Value of Owned Land** | 11000(26.36) | 11000(23.00) | 11000(19.34) | 11000(23.50) |
| **10.** | **Land Revenue** | 40(0.10) | 40(0.08) | 40(0.07) | 40(0.09) |
| **11.** | **Depreciation on Implements** | 480(1.15) | 930(1.94) | 1053(1.85) | 739.83(1.58) |
| **12.** | **Interest on Fixed capital** | 691.2(1.66) | 718.2(1.50) | 725.58(1.28) | 706.79(1.51) |
| **13.** | **Sub Total** | 37937.87(90.91) | 43485.12(90.91) | 51718.95(90.91) | 42551.54(90.91) |
| **14.** | **Managerial cost****@10%ofsubtotal** | 3793.787(9.09) | 4348.512(9.09) | 5171.895(9.09) | 4255.15(9.09) |
| **15.** | **Grand Total** | 41731.65(100.00) | 47833.63(100.00) | 56890.84(100.00) | 46806.7(100.00) |

*\*Figure in parenthesis indicates the percentage.*

**Per hectare costs and in come from production of Mentha:**

According to Table 7, the average costs for categories A1/A2, B1, B2, C1, C2, andC3 were recorded as Rs. 27069.21, Rs. 27776, Rs. 38776, Rs. 31551.54, Rs. 42551.54, and Rs.46806.7, respectively. The average gross revenue amounted to Rs. 141208.8, with a net income of Rs. 94402.1. Among different farm sizes, medium farms generated the highest gross income eat Rs. 163200, followed by small farm sat Rs. 1428000, and marginal farms at Rs. 130560.Medium farms exhibited the highest net income at Rs. 106309.2, followed by small farms at Rs. 94966.3, and marginal farms at Rs. 88828.35. The average house hold labor income was Rs. 102432.8, followed by Rs. 112145.3, Rs. 99436.94, and Rs. 100492.1 for agricultural investment income. Marginal farms had the highest farm investment income, followed by small and medium farms. Family labor income was highest on marginal farms, while farm investment income was highest on/ medium farms, and small and marginal farms had the highest agricultural investment income.

On average, the output per hectare and cost of production per quintal were 138.44quintals and Rs. 337.0803, respectively. The cost-to-output ratios for categories A1/A2,B1,B2,C1,C2, and C3 were recordedat1:5.54,1:5.38,1:3.73,1:4.53,1:3.33,and1:3.03 respectively, based on the average input-output ratio. Small farms exhibited the highest cost-to-output ratio at 1:3.12, followed by medium farms at 1:2.87, and marginal farms at 1:2.98,respectively.

**Table 7: Per-hectare costs and income from the production of Mentha crop on various costs concept (Rs.)**

|  |  |  |
| --- | --- | --- |
| **S.N.** | **Particular** | **Size of sample farms** |
| **Marginal** | **Small** | **Medium** | **Overall average** |
| **1.** | **CostA1/A2** | 19431.86 | 30589.69 | 39329.13 | 27069.21 |
| **2.** | **CostB1** | 20123.06 | 31307.89 | 40054.71 | 27776 |
| **3.** | **CostB2** | 31123.06 | 42307.89 | 51054.71 | 38776 |
| **4.** | **Cost C1** | 26937.87 | 32485.12 | 40718.95 | 31551.54 |
| **5.** | **Cost C2** | 37937.87 | 43485.12 | 51718.95 | 42551.54 |
| **6.** | **Cost C3** | 41731.65 | 47833.63 | 56890.84 | 46806.7 |
| **7.** | **Gross Income** | 130560 | 142800 | 163200 | 141208.8 |
| **8.** | **Net Income** | 88828.35 | 94966.37 | 106309.2 | 94402.1 |
| **9.** | **Family Labour Income** | 99436.94 | 100492.1 | 112145.3 | 102432.8 |
| **10.** | **Farm Investment Income** | 100519.5 | 106684.6 | 118034.7 | 106108.9 |
| **11.** | **Farm Business Income** | 111128.1 | 112210.3 | 123870.9 | 114139.6 |
| **12.** | **Costs of production(q)** | 326.0285 | 341.6688 | 355.5678 | 337.0803 |
| **13.** | **Yield(1/ha)** | 128 | 140 | 160 | 138.44 |
| **14.** | **Input-output relationship** |
| **15.** | **OnthebasisofA1/A2** | 1:6.72 | 1:4.67 | 1:4.15 | 1:5.54 |
| **16.** | **On the basis ofB1** | 1:6.49 | 1:4.56 | 1:4.07 | 1:5.38 |
| **17.** | **OnthebasisofB2** | 1:4.19 | 1:3.37 | 1:3.20 | 1:3.73 |
| **18.** | **OnthebasisofC1** | 1:4.85 | 1:4.39 | 1:4.01 | 1:4.53 |
| **19.** | **OnthebasisofC2** | 1:3.44 | 1:3.28 | 1:3.15 | 1:3.33 |
| **20.** | **On the basis ofC3** | 1:3.12 | 1:2.98 | 1:2.87 | 1:3.03 |

**Summary and conclusion:**

 The data provides an analysis of farm sizes, including marginal, small, and medium farms, and their respective cultivated areas and cropping intensities. Marginal farms, with a total of 48 farms, have a net cultivated area of 0.69 hectares and a gross cultivated area of 1.56hectares, resulting in a cropping intensity of 226.09%. Small farms, numbering 31, have a net cultivated area of 1.27 hectares and a gross cultivated area of 2.72 hectares, with a cropping intensity of 214.17%. Medium farms, comprising 21 farms, show a net cultivated area of 2.11hectares and a gross cultivated area of 4.03 hectares, with a cropping intensity of 190.99%.Overall, the average net cultivated area across all farm sizes is 1.17 hectares, the gross cultivatedareais2.44hectares, and the averagecroppingintensityis208.55%.

The data indicates that marginal farms exhibit the highest cropping intensity at 226.09%, suggesting more frequent use of their land compared to small and medium farms. Small farms also demonstrate a relatively high cropping intensity of 214.17%, while medium farms show a lower cropping intensity of 190.99%. The overall average cropping intensity of 208.55% reflects generally high level of land utilization across all farm sizes. This trend high lights the importance of optimizing land use efficiency, particularly for smaller farms, to maximize agricultural productivity.

**Disclaimer (Artificial intelligence)**

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

Option 2:

Author(s) hereby declare that generative AI technologies such as Large Language Models, etc. have been used during the writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology

Details of the AI usage are given below:

1.

2.

3.

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