

4. PLANNING OF FARM WORK SYSTEM

Management stages (phases) are shown as follows:

1 Analysis stage: To analyze given data.

2 Improvement and optimization stage: To improve and optimize the system.

3 Planning stage: To define an objective for the system, select system components and predict the expected performance of the system.

4-1. Farm Work

4-1-1. Compare and analysis of Effective Field Capacity (EFC)

Case study: To compare and analysis of tillage work rate

| Source | | | TE-2004 | FS-R-L-J |
|-------------------------------------|---------|-------|----------------|----------------|
| Field size | | m * m | 50*35=0.17ha | 30*100=0.30ha |
| Main machine | Name | | Riding Tractor | Riding Tractor |
| Operator | | | Participant | Farmer |
| Theoretical Width | Wt | m | 1.80 | 1.80 |
| Theoretical Speed | Vt | km/h | 2.00 | 2.00 |
| Theoretical Field Capacity | TFC | ha/h | 0.360 | 0.360 |
| Field Efficiency | FE | % | 60.0 | 74.0 |
| Effective Field Capacity_T* | EFC-T | ha/h | 0.216 | 0.266 |
| Area | A | ha | 0.170 | 0.267 |
| Total time | T | h | 1.000 | - |
| Actual operating time | Ta | h | 0.800 | - |
| Effective Field Capacity_E** | EFC_E | ha/h | 0.170 | - |
| Calculated Field Capacity by A/Ta | CFC | ha/h | 0.213 | - |
| Effective Field Capacity by catalog | EFC_cat | ha/h | 0.23 – 0.27 | |
| FE_C = Ta / T * 100 | FE_C | % | 80.0 | - |
| Actual Width | Wa | m | 1.77 | |
| Actual Speed | Va | km/h | 1.20 | |

* EFC_T is calculated by $W \cdot V \cdot FE$

** EFC_E is calculated by A/T

1) EFC of TE-2004 is much less than EFC_T or EFC_cat, discuss why?

2) Field block scale is up like as of standard work (FS-R-L-J), and then EFC become higher than case of TE-2004.

3) Field Efficiency (FE) is shown Table A-232 in appendix.

See fm-22EFC.xls[EFC_411]

Exercise 4-1.

Case study: Compare EFC of manual, animal drawn, small or large type machinery

| | | EFC (ha/h) | WC (h/ha) |
|----------------|---------------|------------|-----------|
| By hand | | 0.0044 | 228.6 |
| Animal drawn | plow by ox | 0.025 | 40.0 |
| | plow by horse | 0.0375 | 26.7 |
| Power tiller | rotary (0.4m) | 0.05 | 20.0 |
| | rotary (0.6m) | 0.08 | 13.3 |
| Riding tractor | rotary (1.6m) | 0.27 | 3.7 |

See fw-data.xls

Exercise 4-2.

Case study: Corner cutting for head feeding combine

Assume harvesting time by hand (MH=) 200 h/ha,

And one corner cutting area (A=) $2\text{m} \times 5\text{m} = 10\text{m} \times 2 = 0.001\text{ ha}$,

Obtain Time of corner cutting by hand (T).

Answer: $T = MH \times A = 0.2\text{ h}$

| symbol | term | unit | case 1 | case 2 | case 3 |
|--------|--------------------------|------|--------|--------|--------|
| T | Total time | h | 0.2 | 0.2 | 0.2 |
| A | Field area of one block | ha | 0.1 | 0.3 | 1.0 |
| EFC | Effective Field Capacity | ha/h | 0.5 | 1.5 | 5.0 |

Case study: Time required for water management etc.

Water management time or finance managing time is different from field operation, and varies widely by its conditions.

Water managing time is assumed as 23.3h/ha seasonally by modifying past data in this text.

Case study: Time required for transportation of materials

Transportation time is out of field operation, so it varies widely by conditions.

4-1-2. Compare and analysis of Daily Capacity, Coverage (CA)

| | | EFC (ha/h) | DC (ha/d) | CA (ha) |
|----------------|---------------|------------|-----------|---------|
| By hand | | 0.0044 | 0.031 | 0.9 |
| Animal drawn | plow by ox | 0.025 | 0.18 | 5.3 |
| | plow by horse | 0.0375 | 0.26 | 7.9 |
| Power tiller | rotary (0.4m) | 0.05 | 0.35 | 10.5 |
| | rotary (0.6m) | 0.08 | 0.56 | 16.8 |
| Riding tractor | rotary (1.6m) | 0.27 | 1.89 | 56.7 |

$DC = EFC \times Dn$, where $Dn = 7\text{h}$

$CA = DC \times AWD$, where $AWD = 30\text{d}$

4-1-3.Machinery capacity from Coverage

How to obtain the optimal machinery capacity, when farm scale or coverage of farm system is given?

Machine will be selected by calculation of field capacity and width of machine as following equations.

$$DC = CA / AWD \quad \text{Eq. 4-1-1}$$

$$EFC = DC / Dn \quad \text{Eq. 4-1-2}$$

$$TFC = EFC / FE * 100 \quad \text{Eq. 4-1-3}$$

$$W = (TFC / V) * 10 \quad \text{Eq. 4-1-4}$$

Where,

| symbol | term | unit | Example 1 | Example 2 |
|--------|----------------------------|------|-------------|-----------|
| | Work name | | Tillage 1 | Tillage 2 |
| | Implement | | Bottom plow | Rotary |
| TFC | Theoretical Field Capacity | ha/h | 0.315 | 0.360 |
| FE | Field Efficiency | % | 71.0 | 74.0 |
| EFC | Effective Field Capacity | ha/h | 0.224 | 0.266 |
| Dn | Net working hours | h/d | 7.2 | 7.2 |
| DC | Daily Capacity | ha/d | 1.61 | 1.92 |
| AWD | Available work days | d | 37 | 37 |
| CA | Coverage | ha | 59.6 | 71.0 |
| v | Speed | km/h | 4.5 | 2.0 |
| W | Width | m | 0.7 | 1.8 |

Exercise. 4-3, 4-4, 4-5, 4-6

See fm-351.xls

4-1-4.Compare and analysis of Total cost, Fixed cost and Variable cost

Total cost of a work (TC_W) and total cost per ha (TCa_W) will be obtained as following equations.

$$TC_W = FC_W + VCa_W * A$$

$$TCa_W = FC_W / A + VCa_W$$

Fix cost of the work (FC_W) will be modified by share (Sp) of the machine in total farm system as next equation.

$$FC_W = FC * Sp / 100$$

Case study: Cost of Rotary Tillage [Table 4-1-1 and 4-1-2]

Choose machinery for each farm scale(A).

Table 4-1-1 Cost of Rotary tillage

| Machine | Case No. | | 1 | 2 | 3 | 4 | 5 | 6 |
|--------------------------|----------|-------|-----------------------------------|-----------|-----------|---------------------------------|-----------|-----------|
| | | | Walking Tractor: 7.5PS | | | Riding Tractor: 46PS | | |
| Purchase Price | P | \$ | 5,400 | | | 41,755 | | |
| Fixed cost | FC | \$ | 921 | | | 7,661 | | |
| Effective Field Capacity | EFC | ha/h | 0.082 | | | 0.252 | | |
| Covered area | CA | ha | 6.2 | | | 19.0 | | |
| Annual fixed cost | FC_W | \$ | 921 | 461 | 184 | 7,661 | 3831 | 1532 |
| Variable cost per ha | VCa | \$/ha | 202 | | | 112 | | |
| Share in system | Sp | % | 100 | 50 | 20 | 100 | 50 | 20 |
| Break even point | Abp | ha | 1.4 | 0.7 | 0.3 | 10.2 | 5.1 | 2.0 |
| Source of data | | | FS-R-S-J-by2005.xls | | | FS-R-L-J-by2005.xls | | |

Where, Custom Charge (CC) = 864 \$/ha, and Working days (DWP) = 19 d

Table 4-1-2 Tillage cost per ha (TCa_W)

| | Walking Tractor: 7.5PS | | | Riding Tractor: 46PS | | | |
|-------|------------------------|-------|-----|----------------------|-------|-------|-------|
| Sp:% | 100 | 50 | 20 | 100 | 50 | 20 | CC |
| A: ha | \$/ha | | | \$/ha | | | \$/ha |
| 0.5 | 2,044 | 1,123 | 570 | 15,434 | 7,773 | 3,176 | 864 |
| 1 | 1,123 | 663 | 386 | 7,773 | 3,943 | 1,644 | 864 |
| 2 | 663 | 432 | 294 | 3,943 | 2,027 | 878 | 864 |
| 3 | 509 | 356 | 263 | 2,666 | 1,389 | 623 | 864 |
| 4 | 432 | 317 | 248 | 2,027 | 1,070 | 495 | 864 |
| 5 | 386 | 294 | 239 | 1,644 | 878 | 418 | 864 |
| 6 | 356 | 279 | 233 | 1,389 | 750 | 367 | 864 |
| 7 | 465 | 334 | 255 | 1,206 | 659 | 331 | 864 |
| 8 | 432 | 317 | 248 | 1,070 | 591 | 304 | 864 |
| 9 | 407 | 304 | 243 | 963 | 538 | 282 | 864 |
| 10 | 386 | 294 | 239 | 878 | 495 | 265 | 864 |
| 11 | 369 | 286 | 235 | 808 | 460 | 251 | 864 |
| 12 | 356 | 279 | 233 | 750 | 431 | 240 | 864 |
| 13 | 415 | 308 | 245 | 701 | 407 | 230 | 864 |
| 14 | 399 | 301 | 241 | 659 | 386 | 221 | 864 |
| 15 | 386 | 294 | 239 | 623 | 367 | 214 | 864 |
| 16 | 375 | 288 | 237 | 591 | 351 | 208 | 864 |
| 17 | 365 | 283 | 235 | 563 | 337 | 202 | 864 |
| 18 | 356 | 279 | 233 | 538 | 325 | 197 | 864 |
| 19 | 396 | 299 | 241 | 918 | 515 | 273 | 864 |
| 20 | 386 | 294 | 239 | 878 | 495 | 265 | 864 |
| 25 | 386 | 294 | 239 | 725 | 418 | 235 | 864 |
| 30 | 356 | 279 | 233 | 623 | 367 | 214 | 864 |

Refer to [Graph of Cost per ha and Total cost vs. Annual operation area]: fm-cost.xls

Exercise 4-7

4-1-5.Summary of cost analysis**Table 4-1-3 Summary of total cost of a tillage work**

| | term | symbol | Formula | unit | Example |
|-----|---|--------|---|-------|---------|
| 1. | Fixed cost | FC | $= P \cdot \text{RAF} / 100$ or $= \text{AD} + \text{AR} + \text{AG} + \text{AI} + \text{AT} + \text{AP}$ | \$ | 921 |
| 1-1 | Depreciation | AD | $= P \cdot \text{RD}$ | \$ | 540 |
| | Depreciation rate | RD | $= 100 / \text{L}$ | % | 10.0 |
| 1-2 | Repair cost | AR | $= P \cdot \text{RR} = \text{TRCf} / \text{L}$ | \$ | 135 |
| | Repair cost rate | RR | $= \text{ER} \cdot \text{rfr} / \text{L}$ | % | 2.5 |
| 1-3 | Garage cost | AG | $= P \cdot \text{RG}$ | \$ | 54 |
| | Garage cost rate | RG | | % | 1.0 |
| 1-4 | Capital interest | AI | $= P \cdot \text{RI} = P / 2 \cdot \text{ri}$ | \$ | 151 |
| | Capital interest rate | RI | $= \text{ri} / 2$ | % | 2.8 |
| 1-5 | Tax fee | AT | $= P \cdot \text{RT}$ | \$ | 27 |
| | Tax fee rate | RT | | % | 0.5 |
| 1-6 | Insurance fee | AP | $= P \cdot \text{RP}$ | \$ | 14 |
| | Insurance fee rate | RP | | % | 0.25 |
| | Annual fixed cost rate | RAF | $= \text{RD} + \text{RR} + \text{RG} + \text{RI} + \text{RT} + \text{RP}$ | % | 17.1 |
| | Share in this system | Sp | | % | 40.0 |
| | Fixed cost of work | FC_W | $= \text{FC} \cdot \text{Sp} = P \cdot \text{RAF} \cdot \text{Sp}$ | \$ | 368 |
| 2. | Variable cost | VCa | $= \text{VMa} + \text{VLa} + \text{VMTa}$ | \$/ha | 202 |
| 2-1 | Machine cost | VMa | $= \text{VFh} + \text{VLUa} + \text{VRa}$ | \$/ha | 35 |
| | Fuel cost | VFh | $= \text{FRh} \cdot \text{Pf}$ | \$/h | 1.34 |
| | Lubricant oil | VLUh | $= \text{VFh} \cdot 0.3$ | \$/h | 0.40 |
| | Repair cost | VRh | $= \text{TRCv} / \text{TSh}$ | \$/h | 1.13 |
| 2-2 | Labor cost | VLh | $= \text{VLh} / \text{EFC}$ | \$/ha | 167 |
| | | VLh | | \$/h | 13.6 |
| 2-3 | Material cost | VMTa | | \$/ha | 0 |
| | Purchase Price | P | | \$ | 5,400 |
| | Economic life | L | ** | year | 10 |
| | Total repair cost coefficient | ER | ** | % | 50.0 |
| | Total service hour | TSh | ** | h | 1,200 |
| | Yearly interest rate | ri | | - | 0.056 |
| | Total repair cost as fixed cost | TRCf | $P \cdot \text{ER} \cdot \text{rfr}$ | \$ | 1,350 |
| | Total repair cost as variable cost | TRCv | $P \cdot \text{ER} \cdot (1 - \text{rfr})$ | \$ | 1,350 |
| | Ratio of fixed to total of repairing cost | rfr | | - | 0.5 |
| | Fuel consumption rate | FRh | | L/h | 3.5 |
| | Price of fuel | Pf | | \$/L | 0.382 |
| | Effective Field Capacity | EFC | | ha/h | 0.08 |

* These data will be converted to data per ha by following equation:

$$\text{VFh} = \text{VLh} / \text{EFC}$$

** See Table A-426

Refer to FM-Plan.xls [4.Machine],[7.Variable]

4-2. Farm Work System

Farm work system is an ordered sequence of farm work operations performed in producing and harvesting a particular crop.

Farm work system is a combination of the various subsystems required for culture of all crops grown on a particular farm.

- (i) Type of work, number of machinery and workers
Maximum number of workers is available or not?
- (ii) Man-hours per ha
Saving labor hour is reasonable or not.
- (iii) Labor productivity (Sales per work hour)
- (iv) Land productivity (Yield or sales amount per ha)
- (v) Coverage of each work and Coverage of system
Minimum coverage of system (Coverage of system) is important limiting factor.

4-2-1. Analysis of Coverage of each work and of system

Table 4-2-1. Summary of farm work system: Example

| No. | Work | TOW | M | Nw | EFC | WC | MH | CA_W |
|-----|----------------------|-----|-----|----|------|------|------|------|
| | | | | | ha/h | h/ha | h/ha | ha |
| 1 | Tillage | M | 1 | 1 | 0.29 | 3.5 | 3.5 | 93.4 |
| 2 | Puddling | M | 1 | 1 | 0.14 | 7.2 | 7.2 | 19.5 |
| 3 | Nursery | C | 0 | 0 | - | - | - | - |
| 4 | Transplanting | M | 1 | 2 | 0.14 | 7.4 | 14.9 | 18.8 |
| 5 | Caring crop | M | 1 | 1 | 0.07 | 14.0 | 14.0 | 11.9 |
| 6 | Chemical application | M | 1 | 3 | 0.53 | 1.9 | 5.7 | 35.1 |
| 7 | Harvest-1 | L | 0 | 1 | 0.50 | 2.0 | 2.0 | 49.7 |
| 8 | Harvest-2 | M | 1 | 1 | 0.06 | 16.7 | 16.7 | 6.5 |
| | | | max | | | sum | sum | min |
| | Work system | | 1 | 3 | | 76.0 | 87.2 | 6.5 |

Where,

| symbol | term | unit | Sample |
|--------|--|------|--------|
| TOW | Type of work: M= Machine, C= Contract, L= Manual | - | - |
| M, Nw | No. of machine, workers | - | - |
| WC | Work capacity | h/ha | 76.0 |
| MH | Man-hours per ha | h/ha | 87.2 |
| A: | Land area: Farm scale | ha | 5.0 |
| CA_W | Coverage of each work | ha | - |
| CA_S | Coverage of system | ha | 6.5 |

See FS01R-Jm.xls

Case study on above table: $CA_S = \text{Min } [CA_{Wi}] = 6.5 \text{ ha}$

Confirm CA_S is larger than A.

Exercise 4-8, 4-9

4-2-2.Coverage of combined works

Work period (DWP) is sometimes overlapped with two or more works, and then the coverage of plural farm works should be examined, because we can not use one machine or one operator at same time of overlapped period.

- a) Plural farm works in the certain overlapped period of one operator

When we need to operate more than two farm works in certain work period, coverage of them will be smaller than each of them.

$$CA_Wp = DCp * AWD \quad \text{Eq. 4-2-1}$$

$$DCp = 1 / DCap = 1 / (DCa1 + DCa2 + \dots) \quad \text{Eq. 4-2-2}$$

Where, $CA_Wp = DCp * AWD$
 $DCp = 1 / DCap$
 $DCap = DCa1 + DCa2 + DCa3 + \dots$

| symbol | term | unit | Example |
|--------|--|------|---------|
| CA_Wp | Coverage of plural works | ha | 2.94 |
| CA_W1 | Coverage of farm work(1) | ha | 7.0 |
| CA_W2 | Coverage of farm work(2) | ha | 5.0 |
| AWD | Available work days | d | 7 |
| DC1 | Daily Capacity of farm work(1) | ha/d | 1.0 |
| DC2 | Daily Capacity of farm work(2) | ha/d | 0.7 |
| DCp | Daily Capacity of plural works | ha/d | 0.42 |
| DCa1 | Daily Capacity per ha, of farm work(1) | d/ha | 1.0 |
| DCa2 | Daily Capacity per ha, of farm work(2) | d/ha | 1.4 |
| DCap | Daily Capacity per ha, of plural works | d/ha | 2.4 |

Exercise 4-10

- b) Plural works in overlapped different work period by one operator

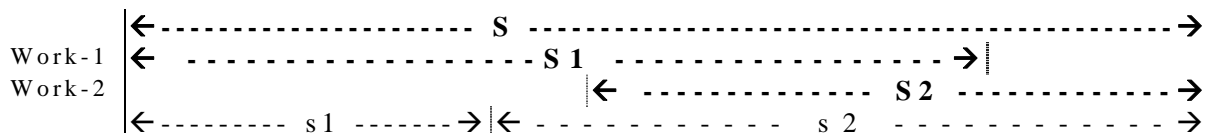


Fig. 4-2-1 Work period overlapped by plural works

If total working day is available without constraint for two works, each time required to work 1,2 and coverage are calculated as following equations.

$$s1 = S * DCa1 / DCap$$

$$s2 = S * DCa2 / DCap \quad \text{Eq. 4-2-3}$$

$$CA = DCp * S \quad \text{Eq. 4-2-4}$$

where, $DCap = DCa1 + DCa2 + DCa3$, and $DCp = 1 / DCap$

(i) Case 1, when $S1 < s1$,

$$CA(1) = S1 / DCa1 \quad \text{Eq. 4-2-5}$$

(ii) Case 2, when $S2 < s2$,

$$CA(2) = S2 / DCa2 \quad \text{Eq. 4-2-6}$$

(iii) Case 3, when $S = s1 + s2$,

$$CA(3) = S / DCap \quad \text{Eq. 4-2-7}$$

Therefore, the coverage of plural works CA_Wp is shown as next equation.

$$CA_Wp = \min [S / DCap, S1 / DCa1, S2 / DCa2] \quad \text{Eq. 4-2-8}$$

| symbol | term | unit | Example |
|--------|--|------|---------|
| S | Total available working day | d | 50 |
| S1 | Available working day for work(1) | d | 40 |
| S2 | Available working day for work(2) | d | 30 |
| s1 | Working day for work(1) if free | d | 16.7 |
| s2 | Working day for work(2) if free | d | 33.3 |
| CA | Coverage of assumed case | ha | 16.7 |
| CA(1) | Coverage of case (1) | ha | 40.0 |
| CA(2) | Coverage of case (2) | ha | 15.0 |
| CA(3) | Coverage of case (3) | ha | 16.7 |
| CA_Wp | Coverage of plural work | ha | 15.0 |
| DC1 | Daily Capacity of farm work(1) | ha/d | 1.0 |
| DC2 | Daily Capacity of farm work(2) | ha/d | 0.5 |
| DCp | Daily Capacity of plural works | ha/d | 0.33 |
| DCa1 | Daily Capacity per ha, of farm work(1) | d/ha | 1.0 |
| DCa2 | Daily Capacity per ha, of farm work(2) | d/ha | 2.0 |
| DCap | Daily Capacity per ha, of plural works | d/ha | 3.0 |

See fm-516DCap.xls

Exercise 4-11

(1) Calculation of CA will be by Linear Programming, if much more complex case.

4-2-3. Analysis of Cost and Profit of system

Total cost (TC_S), Fixed cost (FC_S), Variable cost (VCa_S) and Break even point (Abp), Profit (PR) and Cost index (CI) etc. are examined as follows.

$$TC_S = \sum (TC_{Wi}) = FC_S + VCa_S * A \quad \text{Eq. 4-2-9}$$

$$TCa_S = FC_S / A + VCa_S \quad \text{Eq. 4-2-10}$$

Table 4-2-2 Summary of farm work system: Example

| | | TO W | M | Nw | EFC | MH | FC | VCa | CA | TCa | CC | CI |
|------------------|-------------------------|---------|---|----|------|-------|--------|-------|------|-------|-------|------|
| | | | - | - | ha/h | h/ha | \$ | \$/ha | ha | \$/ha | \$/ha | % |
| 1 | Prepare seed | L | 0 | 2 | 0.00 | 3.8 | 0 | 70 | 17.2 | 70 | | 0.7 |
| 2 | Nursery | M | 1 | 2 | 0.08 | 37.5 | 2,129 | 449 | 12.6 | 662 | 1,455 | 6.4 |
| 3 | Tillage | M | 1 | 1 | 0.08 | 4.0 | 1,916 | 112 | 19.0 | 304 | 636 | 2.9 |
| 4 | Basal dressing | M | 1 | 2 | 0.16 | 1.3 | 1,193 | 456 | 48.1 | 575 | | 5.6 |
| 5 | Puddling | M | 1 | 1 | 0.21 | 1.8 | 1,612 | 50 | 19.6 | 211 | 864 | 2.0 |
| 7 | Transplanting | M | 1 | 2 | 0.44 | 6.2 | 4,074 | 98 | 12.5 | 506 | 636 | 4.9 |
| 8 | Herbicide ap. | L | 1 | 1 | 0.04 | 2.3 | 7 | 604 | 12.2 | 605 | | 5.9 |
| 9 | Weeding | M | 1 | 1 | 0.40 | 12.0 | 203 | 643 | 10.7 | 664 | 557 | 6.4 |
| 10 | Pest control-1 | M | 1 | 3 | 1.85 | 1.6 | 2,385 | 46 | 39.5 | 285 | | 2.8 |
| 12 | Pest control-2 | M | 1 | 3 | 1.23 | 2.4 | 2,385 | 96 | 26.3 | 335 | | 3.2 |
| 14 | Top-dressing | L | 0 | 2 | 0.04 | 12.0 | 0 | 202 | 11.4 | 202 | | 2.0 |
| 15 | Water management | L | 0 | 1 | 0.11 | 23.3 | 0 | 318 | 25.5 | 318 | | 3.1 |
| 16 | Harvesting & threshing | M | 1 | 2 | 0.03 | 8.5 | 8,953 | 133 | 30.1 | 1,029 | 1,636 | 10.0 |
| 17 | Harvesting Transporting | M | 1 | 2 | 0.00 | 3.1 | 86 | 44 | 84.4 | 52 | | 0.5 |
| 18 | Drying | M | 1 | 2 | 0.00 | 6.9 | 1,942 | 91 | 27.1 | 285 | 1,023 | 2.8 |
| 19 | Husking | M | 1 | 2 | 0.00 | 8.3 | 506 | 97 | 16.8 | 148 | 341 | 1.4 |
| Work system(*_S) | | | 1 | 3 | | 147.3 | 27,650 | 3,684 | 10.3 | 6,449 | | 62.5 |

See FS-R-L-J.xls

Where,

| symbol | term | unit | Sample |
|------------------|--|-------|---------|
| TOW | Type of work: M= Machine, C= Contract, L= Manual | - | |
| M, Nw | No. of machine, workers | - | |
| MH | Man-hours per ha | h/ha | 147.3 |
| FC _S | Annual fixed cost | \$ | 27,650 |
| VCa _S | Variable cost per ha | \$/ha | 3,683 |
| TCa _S | Annual cost per ha at A | \$/ha | 6,449 |
| A: | Land area | ha | 10.0 |
| CA _S | Coverage of system | ha | 10.3 |
| Y: | Yield per year | t/ha | 4.5 |
| LDP: | Land productivity = Y * Crop Price (=PSa) | \$/ha | 10,313 |
| SH : | Sales per working hour of this system = (LBP) | \$/h | 70.0 |
| Abp: | Break-even point | ha | 4.2 |
| CI : | Cost per ha/ Sales per ha of system | % | 62.5 |
| Pra | Profit per ha of system | \$/ha | 3,864 |
| PS | Total Sales at A (= LDP*A) | \$ | 103,132 |
| TC _S | Total Cost of system at farm scale: A (=TCa _S *A) | \$ | 64,492 |
| PR | Total Profit of system at A | \$ | 38,640 |

Case study:

(i) Total fixed cost of the farm work system

Total fixed cost etc. of the farm work system will be calculated by summation of each item of farm work correspond to the certain annual farm work area.

Table 4-2-3 Total fixed cost of a farm work system: Example

| Annual farm work area | Fixed cost per ha | Variable cost per ha | Cost per ha |
|-----------------------|-------------------|----------------------|-------------|
| Aa | FCa | VCa | TCa |
| (ha) | (\$/ha) | (\$/ha) | (\$/ha) |
| 1 | 27,650 | 3,684 | 31,334 |
| 5 | 5,530 | 3,684 | 9,214 |
| 10 | 2,765 | 3,684 | 6,449 |
| 15 | 1,843 | 3,684 | 5,528 |
| 20 | 1,382 | 3,684 | 5,067 |
| 25 | 1,106 | 3,684 | 4,790 |
| 30 | 922 | 3,684 | 4,606 |

See FS-R-L-J.xls

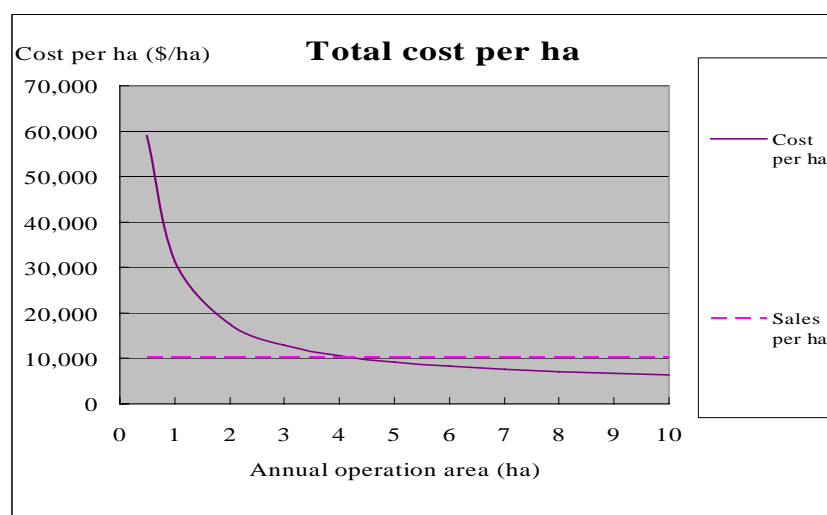


Fig. 4-2-2 Total cost per ha of a farm work system

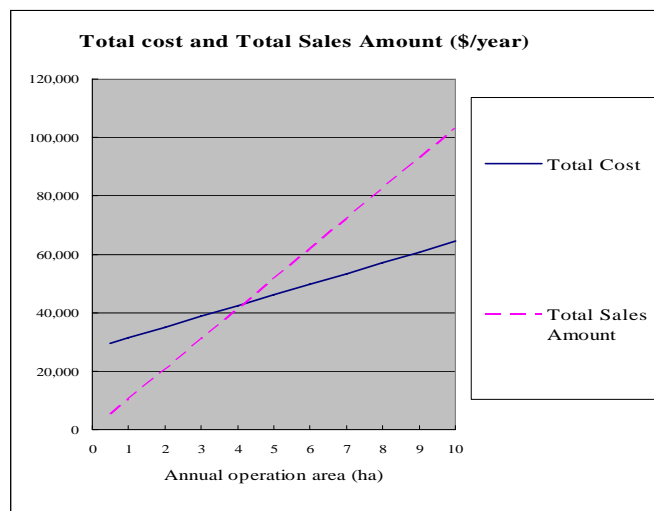


Fig. 4-2-3 Total cost and sales amount

See FS-R-L-J.xls

(ii) Annual cost per ha at several farm scale

Exercise 4-13, 4-14, 4-15, 4-16

(iii) Break-even point of system

Break-even point or Cross point of rice sales and farm work cost is an important key-point for analyzing the farm work system.

If the cost of farm work system is more than the sales of rice, that is, the expense is larger than income, there is no profit by this farm work system. The break-even point of area shows the point, that there is profit by the system if the farm scale is larger than this point. The break-even point of area is calculated as follows.

$$PSa * Abp = FC + VCa * Abp \quad \text{Eq. 4-2-11}$$

or

$$PSa = VCa + FC / Abp \quad \text{Eq. 4-2-12}$$

$$Abp = FC / (PSa - VCa) \quad \text{Eq. 4-2-13}$$

Exercise 4-17

Terms for Break-even point analysis

| symbol | term | unit | Example |
|--------|--|-------|---------|
| Rvc | Variable cost ratio = VCa/PSa | - | 0.357 |
| Cp | Critical profit unit = $PSa - VCa$ | \$/ha | 6630 |
| CRp | Critical profit ratio = $Cp / PSa = 1 - Rvc$ | - | 0.643 |
| Rs | Safety ratio = $1 - (Abp / A)$ A=10ha | - | 0.580 |

(iv) Cost performance (Cost index of farm work)

Cost performance is basic index for economic evaluation. Here, we calculate the ratio cost per ha to sales per ha as Cost index of farm work (CI).

If Cost index is over 100%, it means no profit.

(v) Total profit of system

$$\begin{aligned} \mathbf{PR} &= \mathbf{PS} - \mathbf{TC} = \mathbf{PSa} * \mathbf{A} - (\mathbf{FC} + \mathbf{VCa} * \mathbf{A}) \\ &= (\mathbf{PSa} - \mathbf{VCa}) * \mathbf{A} - \mathbf{FC} \end{aligned} \quad \mathbf{Eq. 4-2-14}$$

(vi) Profit per ha of system

$$\mathbf{PRa} = \mathbf{PSa} - \mathbf{TCa} \quad \mathbf{Eq. 4-2-15}$$

(vii) Income of family farm

Income of family farm is obtained by applying the expense accounting method, and will be shown as follows:

$$\mathbf{NI} = \mathbf{PR} + \mathbf{VCLB} \quad \mathbf{Eq. 4-2-16}$$

| symbol | term | unit | Example in FS01R-J |
|--------|---------------------------|------|--------------------|
| NI | Net Income of family farm | \$ | 81,250 |
| PR | Profit | \$ | 71,480 |
| VCLB | Labor Cost | \$ | 9,770 |

See FM-Plan.xls and FS01R-Jm.xls

Exercise 4-18

(viii) Other expenses and income

All other expenses and income will be included for cost analysis, if necessary.

| symbol | term | unit | Example |
|--------|-----------------------------------|------------|---------|
| LIC | Land improvement or consolidation | \$/ha/year | 533 |
| WUR | Water utilization or rate | \$/ha/year | 417 |
| LR | Land rent | \$/ha/year | 1222 |
| MC | Management cost | \$/ha/year | 67 |
| AI | Interest | \$/ha/year | 83 |
| LT | Land tax | \$/ha/year | 123 |
| CIS | Crop insurance (rice) | \$/ha/year | 355 |
| BYP | Value of by-product | \$/ha/year | 250 |

See FM-plan.xls : 1.Pre. and Ag-cost1.xls

4-2-4. Farm work system

Table 4-2-4. Arrangements of Farm work system

| | | | |
|-----------------------------|--|---|---|
| 1.Pre-condition of farming | Case of precondition for farm mechanization system 1. Application area (topography, weather condition etc) 2. Management system and improvement target 3. Field condition (including farm road, size of field, shape) 4. Object of machinery utilization and total operation area 5. Actual condition of farm house hold. 6. Budget for purchase machinery and controlling the management of group farming system. | | |
| 2.Preparation of farm works | Make out the schedule and plan for land utilization table | Make out the crop cultivation method | Make out the machinery operation schedule |
| 3.Mechanization plan | Make out the cultivation plan of object crop and systematic mechanization table of each crop. | | |
| 4.Examine of planning | Examine the coverage in calculation table. | Examine the working plan and required labor input | Examine the production cost |

4-2-5.Precondition

Table 4-2-5. Precondition for Farm work system

| Items | | Precondition |
|---|----------------------------|--|
| 1. Region and farming area | | Location and area |
| 2. Management system and its improvement target. | | You must clear the following farmer's group such as full time farmer or individual farmer. Clear the improvement target of object crop and its management. |
| 3. Cropping system | | Select crops. Plan cropping system, one or two, cropping system or mixed farming |
| 4. Field condition | | Field size and shape. Soil conditions. Farm road etc. |
| 5. Actual condition of farmers | Number of farm-house hold | We must arrange and to investigate actual situation of number of farm house hold, total cultivated area, total labour, condition and availability of labour and total farm machinery in planning area. |
| | Total cultivated area | |
| | Laborer available | |
| | Owned total farm machinery | |
| 6. Capital available for buying machinery and its management. | | At first, we must clear the cost calculation of machinery, capital available for buying machine, and management's fee etc. |
| 7. Cultivation method | | Name of crop, Variety Planting pattern, Estimate yield per ha Covered area |
| 8. Machinery set | | |

Example:

1. Rice crop cultivation: Table 4-2-6 and -7. is an example of North Kanto plain area in Japan.
2. Other examples: Wheat: fm_5_1b.xls., Corn: fm_5_1c., Potato: fm_5_1d., Soybean: fm_5_1e.xls refer to Excel files.

Table 4-2-6. Mechanization Planning for Rice Transplanting Method in Paddy Field (Example)

1. Pre-condition

| Name of crop | Variety | Planting pattern | Yield per ha | Cultivated area | Size of field and shape | Covered area | Main farm machinery use |
|--------------|------------|--|---------------------|------------------------------------|-------------------------|--------------|---|
| paddy rice | Akinishiki | rows 30 cm x 13 cm, 25.6 hills/m ² , 3 to 5 plants/hill | (estimate) 4,500 kg | Kita-Kanto plain area. paddy field | 30 a (100 m x 30 m) | 10 ha | 46 P.S. tractor, 6 rows Rice Transplanter, 4 row type combine |

See FS01R-Jm.xls

Table 4-2-7. Mechanization Planning for Rice Transplanting Method in Paddy Field (Example)

2. Table for operation

| Items | Cultivation standard | | | Operation standard | | | Operation hours per ha (h/ha) | | | Fuel consumption | |
|-----------------------------------|----------------------|---|-------------|---|---------------------|----------------|-------------------------------|-----------|--------|------------------|------|
| Name of operation | Period of operation | Materials use (per ha) | Prime mover | Name of farm Machinery | accuracy & method | Field capacity | Mac hiner y | Wo rke rs | Total | | |
| | | | | | | ha/h | h/ha | | h/ha | | L/h |
| Preparation of seed | 5.14-5.20 | Seed 35 kg, salt 10 kg, Benlate-T 400 g, Sumithion 80 cc | Manual | | | | | 2 | 1.90 | | |
| Nursery | 5.20-6.25 | | Manual | | | | | 2 | 37.50 | | |
| Tillage | 6.12-6.19 | | Tractor | Rotary 1.8 m | depth 13 cm | 0.267 | 3.74 | 1 | 3.74 | D | 6 |
| Basal dressing fertilizer | 6.12-6.19 | comp. fertilizer, (10,18,16) 700 kg | Tractor | Broadcaster 300 L | | 1.515 | 0.66 | 2 | 1.32 | D | 4.3 |
| Puddling | 6.20-6.28 | | Tractor | puddling harrow 2.4 m width | | 0.549 | 1.82 | 1 | 1.82 | D | 5.5 |
| Transporting seedling | 6.20-6.29 | | Tractor | Trailer with seeding box shelves | | 0.21 | 4.77 | 2 | 9.54 | G | 4 |
| Rice transplanting | 6.21-6.29 | | Self-propel | Riding type 6 row Rice transplanter | | 0.172 | 5.81 | 2 | 11.62 | D | 0.7 |
| Herbicide application | 6.26-7.3 | Saturn M 30 kg | Manual | Granule spreader * | | | 2.28 | 1 | 2.28 | | |
| Top-dressing & spraying | 7.5-7.10 | ammonium sulfate 100 kg, Diazinon Granule 30 kg | Manual | | mixed spray | | | 1 | 2.62 | | |
| Pest & Disease control/ | | | | | | | | | | | |
| Rice skipper, Sheath blight | 8.3-8.7 | Dipterex 1.0 L Neo-Asozin 0.7 L | Tractor | Tractor mount type sprayer, levee nozzle, mixed spray | | 1.852 | 0.54 | 6 | 3.24 | D | 3 |
| | | | | | | 1.852 | 0.54 | 2 | 1.62 | G | 4 |
| Stem borer Leaf hopper Leaf Blast | 8.25-8.29 | Sumithion 1.5 L Bassa 1.0 L Validacim 1.5 L Kitazin 1.5 L | Tractor | Tractor mount type sprayer, levee nozzle, mixed spray | | 1.235 | 0.81 | 6 | 4.86 | D | 3 |
| | | | | | | 1.235 | 0.81 | 2 | 1.62 | | 4 |
| Top-dressing | 8.10-8.15 | comp. fertilizer (17,0,16) 120 kg | Manual | | | | | 1 | 6.00 | | |
| Water management | "6-9" | | Manual | | | | | 1 | 96.00 | | |
| Harvest/ | | | | | | | | | | | |
| Harvesting & threshing | 10.20-11.5 | | Self-propel | Head feeding type 4 row combine | | 0.115 | 8.66 | 2 | 17.32 | D | 3.9 |
| Transporting | 10.20-11.5 | | Truck | 1 ton truck | | 0.654 | 1.53 | 2 | 3.06 | G | 4 |
| Drying | 10.20-11.6 | Tempering (Circulated) | Motor | 21 koku (3780L) | Moisture 21.3-14.0% | | 34.5 | 2 | 9.56 | K | 2.9 |
| Husking | 10.21-11.7 | | Motor | Husker roll width 76mm | | 0.24 | 4.17 | 3 | 12.50 | | |
| Rice straw turn over | 10.23-11.8 | | Tractor | Tedder & rake (3.0m width) | | 1 | 1 | 1 | 1.00 | D | 6.1 |
| Rice straw gathering | 10.24-11.9 | | Tractor | Tedder & rake (3.0 m width) | | 0.909 | 1.1 | 1 | 1.10 | D | 5.5 |
| Rice straw bale | 10.24-11.9 | | Tractor | Baler (1.4m width) | | 0.68 | 1.47 | 2 | 2.94 | D | 10.4 |
| Total | | | | | | | 74.21 | | 232.63 | | |

D: Diesel ,G: Gasoline, K: Kerosene

4-2-6.Planning table for farm mechanization

After you decide the precondition of planning, you can make farm mechanization planning table.

Table 4-2-8. Planning table of rice cultivation

| Farm work | | T O W | Main machine | | M | Nw | Rate of work | | Working period | | | Coverage |
|-----------|----------------------|-------------|--------------|----------------------|---|----|--------------|-------|----------------|--------|-----|----------|
| No | Name | | No | Name | | | EFC | DC | DATES | DATEE | DWP | CA |
| | | | | | - | - | ha/h | ha/d | - | - | d | ha |
| 1 | Tillage | M | 1 | Tractor | 1 | 1 | 0.286 | 1.829 | 8.Feb | 18.Apr | 70 | 93.4 |
| 2 | Puddling | M | 1 | Tractor | 1 | 1 | 0.110 | 0.703 | 20.Apr | 19.May | 30 | 15.4 |
| 3 | Nursery | C | 99 | None | 0 | 0 | - | - | 2.Apr | 21.May | 50 | - |
| 4 | Trans-planting | M | 4 | Rice trans-planter | 1 | 2 | 0.134 | 0.860 | 22.Apr | 21.May | 30 | 18.8 |
| 5 | Caring crop | M | 5 | Power Weeder | 1 | 1 | 0.072 | 0.396 | 2.Jun | 21.Jul | 50 | 11.9 |
| 6 | Chemical application | M | 6 | Power Sprayer | 1 | 3 | 0.529 | 2.923 | 3.Jul | 22.Jul | 20 | 35.1 |
| 7 | Harvest-1 | L | 99 | Corner by hand | 0 | 1 | 1.500 | 8.289 | 12.Sep | 11.Oct | 30 | 149.1 |
| 8 | Harvest-2 | M | 7 | Head feeding combine | 1 | 1 | 0.164 | 0.907 | 12.Sep | 11.Oct | 30 | 17.8 |
| 9 | Drying | C | 99 | None | 0 | 0 | - | - | 13.Sep | 11.Nov | 60 | - |
| 10 | Husking | C | 99 | None | 0 | 0 | - | - | 15.Sep | 13.Nov | 60 | - |
| 11 | Water management | L | 99 | None | 0 | 1 | 0.043 | 0.000 | 2.Apr | 1.Oct | 183 | - |

Where,

| symbol | term | unit |
|-----------|--|------|
| TOW | Type of work: M= Machine, C= Contract, L= Manual | - |
| M, Nw | No. of machine set, workers | - |
| EFC | Effective Field Capacity | ha/h |
| DC | Daily Capacity | ha/d |
| DATES, -E | Starting date or Ending date | - |

Refer to FS01R-J

Exercise 4-19.

4-2-7. Comparing of farm work systems

Compare and discuss on the several farm work systems: Table 4-2-9.

- (i) Work system name with crop
- (ii) Type of data: Experimental, Statistical, Reference etc.
- (iii) Region or country and Farm scale of the system
- (iv) Maximum workers available and Total man –hours per ha
- (v) Annual cost per ha at farm scale 1, 10, 20 ha and at coverage
- (vi) Sales amount of product
- (vii) Cost index at the farm scale (Cost performance)
- (viii) Sales per working hour (Labor productivity)
- (ix) Profit per ha of system
- (x) Break-even point

Table 4-2-9 Comparing of several farm work systems

| N o. | System | Type | A | Nw - ma x | MH | FC | VCa | TCa | PSa | CI | SH |
|---------|--------|----------------|----|--------------------|------|--------|--------|--------|--------|-----|------|
| | | | ha | | h/ha | \$ | \$/ha | \$/ha | \$/ha | - | \$/h |
| 1 | FS0m-J | Ref. | 1 | 3 | 983 | 288 | 13,960 | 14,247 | 10,309 | 138 | 11 |
| 2 | FS0a-J | Ref. | 1 | 3 | 683 | 393 | 10,925 | 11,318 | 10,309 | 110 | 15 |
| 3 | FS-R-S | Ref. | 2 | 3 | 249 | 4,631 | 6,733 | 9,049 | 10,309 | 88 | 41 |
| 4 | FS-R-L | Ref. | 10 | 3 | 192 | 19,985 | 3,585 | 5,584 | 10,309 | 43 | 68 |
| 5 | Rice | Stat.: 2000 | 1 | 3 | | | | 9,925 | 9,895 | 100 | |
| 6 | Rice | Stat.: 2000 | 10 | 3 | | | | 6,463 | 9,895 | 65 | |
| 7 | Wheat | Stat.: 1998 | 1 | 1 | | | | 3,706 | 4,701 | 79 | |

Note: 1. FS0m-J: Manual farm work system estimated in Japan by references
 2. FS0a-J: Animal farm work system estimated in Japan by references

Where,

| symbol | term | unit |
|--------|--|-------|
| A | Farm scale of system | ha |
| Nw-max | Number of workers available | - |
| MH | Total Man-hours per ha | h/ha |
| FC | Annual fixed cost | \$ |
| VCa | Variable cost per ha | \$/ha |
| TCa | Annual cost per ha at farm scale | \$/ha |
| PSa | Sales per ha | \$/ha |
| CI | Cost index (x100): = Cost per ha/ Sales per ha | - |
| SH | Sales per working hour | \$/h |
| PRa | Profit per ha of system | \$/ha |

Refer fm-515.xls : Compare-system, bunken/NOUKI/Ag-cost1.xls

Exercise 4-20.

4-3. Exercise

Exercise 4-1. Modify the data of TE to as of normal field size

Exercise 4-2. Discuss the EFC of case study below.

| | | EFC (ha/h) | WC (h/ha) |
|----------------|---------------|------------|-----------|
| By hand | | 0.0044 | 228.6 |
| Animal drawn | plow by ox | 0.025 | 40.0 |
| | plow by horse | 0.0375 | 26.7 |
| Power tiller | rotary (0.4m) | 0.05 | 20.0 |
| | rotary (0.6m) | 0.08 | 13.3 |
| Riding tractor | rotary (1.6m) | 0.27 | 3.7 |

Exercise 4-3. Obtain the required capacity of machinery and the width of machine (Wt) , when data are given in next table.

| symbol | term | unit | rotary tillage |
|--------|-----------------------------|------------|----------------|
| EFC | Effective Field Capacity | ha/h | |
| A | Area | ha | 15 |
| AWD | Available work days | d | 12 |
| Dn | Net work hours per day | h/d | 6 |
| Wt | Theoretical operation width | m | |
| Vt | Theoretical operation speed | km/h | 2.0 |
| fe | Field efficiency | in decimal | 0.75 |

Exercise 4-4. How many machinery sets are necessary to next farm.

| symbol | term | unit | example |
|--------|-----------------------|------|---------|
| M | Number of machine set | - | |
| A | Area | ha | 50 |
| CAS | Coverage of one set | ha | 13 |

Exercise 4-5. : How many tractors and implements are required for the following farm work by 35PS tractor (Area: A = 50 ha and Available net working hour: ANWH=250 h)

| Farm work | Implement | Work capacity: WC h/ha | Number of operation: N times | Required number of implement |
|-----------|--------------|---------------------------|---------------------------------|------------------------------|
| Tillage | Rotary | 5 | 1 | |
| Harrow | Rotary | 4 | 2 | |
| Leveling | Tooth harrow | 1 | 2 | |
| Seeding | Grain drill | 3 | 1 | |
| Pressing | Roller | 2 | 1 | |

Exercise 4-6. : List up works and machinery of your conventional farm.
(use FM-Plan-for_conventional.xls)

Exercise 4-7. Discuss the costs of tillage at farm scale of 1 ha.

Discuss how about the costs at 10ha farm scale.

Discuss how to improve share of them actually.

Use Table 4-1 1 Cost of Rotary tillage

Exercise 4-8. We have farm work system data of our theme experiment as following table. What and how farm work should be improved for more coverage.

Exercise 4-9. Discuss the idea and plan for more economical farm work system in case of 10ha farm scale.

| | Farm work | Daily Capacity | No. of machine set | Working days | Rate of available day | Available work days | Coverage of one set |
|----|----------------------|----------------|--------------------|--------------|-----------------------|---------------------|---------------------|
| | | DC | M | DWP | ADR | AWD | CAS |
| No | Name | ha/d | - | d | % | d | ha |
| 1 | Tillage | 1.83 | 1 | 70 | 73 | 51.1 | 93.5 |
| 2 | Puddling | 1.92 | 1 | 30 | 73 | 21.9 | 42.0 |
| 3 | Transplanting | 1.34 | 1 | 30 | 73 | 21.9 | 29.4 |
| 4 | Caring crop | 0.44 | 1 | 47 | 65 | 30.6 | 13.5 |
| 5 | Chemical application | 2.92 | 1 | 47 | 65 | 30.6 | 89.5 |
| 6 | Harvest | 0.33 | 1 | 47 | 65 | 30.6 | 10.1 |
| 7 | Drying | | 1 | 47 | 65 | 30.6 | 1000.0 |

Exercise 4-10.

Obtain Coverage of plural works (CA_Wp), when Daily Capacity of farm work-1 (DC1) =1 ha/d, Daily Capacity of farm work-2 (DC2) =0.5 ha/d and Available work days (AWD) =50 d.

Exercise 4-11. When the farm work period schedule is given as following table, obtain the coverage of these farm work.

| | |
|--------|----------------------------------|
| | ←----- S -----→ |
| Work-1 | ←-----S1 -----→ |
| Work-2 | ←----- S2 -----→ |
| | ←----- s1 -----→←----- s2 -----→ |

Where,

| Symbol | term | | Work Capacity: WC |
|--------|-----------------------------------|----|-------------------|
| | | d | d/ha |
| S | Total available working hour | 20 | |
| S1 | Available working hour for work-1 | 14 | DCa1 = 8.0 |
| S2 | Available working hour for work-2 | 8 | DCa2 = 2.0 |

Exercise 4-12. Obtain Maximum number of workers, Total Man-hours per ha, Coverage of system, Annual total cost per ha at farm scale of 10 ha, and cost index of each work and at farm scale 10 ha in next table.

Assume, Sales per ha = 12,015 \$/ha

| N o | Work | M | N w | MH | FC | VCa | CA | TC-10ha | CI-10ha |
|--------|----------------------|-----|--------|------|--------|-------|-----|---------|---------|
| | | - | - | h/ha | \$ | \$/ha | ha | \$/ha | |
| 1 | Tillage | 1 | 1 | 3.5 | 0 | 79 | 93 | 79 | 0.7 |
| 2 | Puddling | 1 | 1 | 3.3 | 1,350 | 74 | 42 | | |
| | Nursery | | | | 0 | 1,230 | - | | |
| 3 | Transplanting | 1 | 2 | 9.5 | 4,050 | 100 | 29 | | |
| 4 | Caring crop | 1 | 1 | 12.5 | 324 | 153 | 13 | 185 | 1.5 |
| 5 | Chemical application | 1 | 3 | 5.7 | 549 | 118 | 87 | 173 | 1.4 |
| 6 | Harvest | 1 | 2 | 33.3 | 4,500 | 330 | 6.5 | 780 | 6.5 |
| 7 | Drying | 0 | 0 | 0.0 | 0 | 865 | - | 865 | 7.2 |
| 8 | Husking | 0 | 0 | 0.0 | 0 | 288 | - | 288 | 2.4 |
| 9 | Water manage | 0 | 1 | 0.0 | 0 | 269 | - | 269 | 2.2 |
| | | max | | sum | sum | sum | min | sum | sum |
| | Work system | 1 | | | 10,773 | 3,506 | | | |

Where,

| symbol | term | unit |
|---------|--|-------|
| TOW | Type of work: M= Machine, C= Contract, L= Manual | - |
| M, Nw | No. of machine, workers | - |
| WC | Work capacity | h/ha |
| MH | Man-hours per ha | h/ha |
| FC | Annual fixed cost | \$ |
| VCa | Variable cost per ha | \$/ha |
| CA | Covered area | ha |
| TC-10ha | Annual total cost per ha at farm scale of 10ha | \$/ha |
| CI | Cost index (x100): =Cost per ha/ Sales per ha | - |

Exercise 4-13. Obtain the total profit and the profit per ha of a farm work system give in next table.

| symbol | term | unit | Example |
|--------|----------------------------------|-------|---------|
| PSa | Sales per ha | \$/ha | 12,015 |
| PS | Total Sales at area = Farm scale | \$ | |
| FC | Annual fixed cost | \$ | 10,773 |
| A | Farm scale | ha | 10.0 |
| VCa | Effective Field Capacity | \$/ha | 3,438 |
| TCa | Cost per ha at area = Farm scale | \$/ha | |
| TC | Total Cost at area = Farm scale | \$ | |
| PR | Total Profit | \$ | |
| PRa | Profit per ha: | \$/ha | |

Exercise 4-14. When annual operation area is larger than the coverage, we need to supply the additional machinery or worker, and machinery cost is calculated accordingly.

$$M_{sys} = \text{INT}(A_a / C_{AS} + 1)$$

$$F_{Ca} = F_{Cs} * M_{sys} / A_a$$

Where,

| symbol | term | unit | Example |
|--------|-----------------------------------|-------|---------|
| Msys | Number of machinery set of system | - | |
| Aa | Annual farm work area | ha | |
| INT | Function of getting integer | - | - |
| CAS | Coverage of one set | ha | 10.1 |
| FCa | Fixed cost per ha | \$/ha | |
| FCs | Annual fixed cost of one set | \$ | 4,500 |

Fill the blank columns of next table.

| Annual farm work area | No. of set | Annual total fixed cost | Fixed cost per ha |
|-----------------------|------------|-------------------------|-------------------|
| Aa | Msys | FC | FCa |
| (ha) | - | \$ | (\$/ha) |
| 1 | 1 | 4,500 | 4,500 |
| 5 | | | |
| 10 | | | |
| 15 | | | |
| 20 | | | |
| 30 | | | |

Exercise 4-15. Obtain Annual Total fixed cost (FC) of the farm work system from next table of each farm work. Examine cost per ha (TCa) of them.

Variable cost per ha(VCa)=3,439\$/ha

| | Annual fixed cost of each farm work(FC) | | | | | | | | | No. of set | Farm work system | | | |
|------|---|-------|-------|-----|-----|--------|---|---|---|------------------|------------------|--------|-------|--------|
| Area | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | FC | FCa | VCa | TCa |
| ha | \$ | | | | | | | | | | \$ | \$/ha | \$/ha | \$/ha |
| 1 | 0 | 1,350 | 4,050 | 324 | 549 | 4,500 | 0 | 0 | 0 | 1 | 10,773 | 10,773 | 3,439 | 14,212 |
| 5 | 0 | 1,350 | 4,050 | 324 | 549 | 4,500 | 0 | 0 | 0 | 1 | 10,773 | 2,155 | 3,439 | 5,593 |
| 10 | 0 | 1,350 | 4,050 | 324 | 549 | 4,500 | 0 | 0 | 0 | 1 | | | 3,439 | |
| 15 | 0 | 1,350 | 4,050 | 648 | 549 | 9,000 | 0 | 0 | 0 | 2 | | | 3,439 | |
| 20 | 0 | 1,350 | 4,050 | 648 | 549 | 9,000 | 0 | 0 | 0 | 2 | | | 3,439 | |
| 25 | 0 | 1,350 | 4,050 | 648 | 549 | 13,500 | 0 | 0 | 0 | 3 | | | 3,439 | |
| 30 | 0 | 1,350 | 8,100 | 972 | 549 | 13,500 | 0 | 0 | 0 | 3 | 24,471 | 816 | 3,439 | 4,254 |

Exercise 4-16 Obtain Annual total cost at farm scale 1, 10, 30 ha, Sales amount of product, Cost index at the farm scale, no. 2,3,4 in next table.

| No. | System | Type | FC | VCa | A | TC-1ha | TC-10ha | TC-30ha | PSa |
|-----|--------|------|--------|-------|-----|--------|---------|---------|--------|
| | | | \$ | \$/ha | ha | \$/ha | \$/ha | \$/ha | \$/ha |
| 1 | FS01-J | TE | 10,773 | 3,506 | 6.5 | 14,279 | 4,583 | 3,865 | 12,015 |
| 2 | FS01-X | TE | 10,000 | 3,000 | 10 | | | | 12,000 |
| 3 | FS01-Y | TE | 12,000 | 2,500 | 20 | | | | 12,000 |
| 4 | FS01-Z | TE | 15,000 | 2,000 | 30 | | | | 12,000 |

Where,

| symbol | term | unit | 1 | 2 | 3 | 4 |
|--------|---------------------------------------|-------|-------|------|------|------|
| A | Farm scale of system | ha | 6.5 | 10 | 20 | 30 |
| Nw-max | Number of workers available | - | 3 | 3 | 3 | 3 |
| TMH | Total Man-hours per ha | h/ha | 68 | 50 | 40 | 30 |
| FC | Annual fixed cost | \$ | | | | |
| VCa | Variable cost per ha | \$/ha | | | | |
| TC-* | Annual cost per ha at farm scale of * | \$/ha | - | - | - | - |
| PSa | Sales per ha | \$/ha | | | | |
| PRa | Profit per ha | \$/ha | 6,852 | | | |
| Abp | Break-even point | ha | 1.27 | 1.11 | 1.26 | 1.50 |
| CI | Cost index (x100): = Cost / Sales | - | 43 | | | |

Exercise 4-17. Obtain the break-even point of area, using next table.

| symbol | term | unit | Example |
|--------|----------------------------|-------|---------|
| PSa | Sales per ha | \$/ha | 12,015 |
| Abp | Break-even point of area | ha | |
| FC | Annual total fixed cost | \$ | 10,773 |
| VCa | Total variable cost per ha | \$/ha | 3,439 |

Exercise 4-18. Obtain Net Income of family farm, when Profit=2,600\$ and Labor Cost = 750\$.

Exercise 4-19. Discuss on coverage of each work on Table4-2-8.

Exercise 4-20. Discuss on Man-hours per ha, Total cost per ha and Cost index on Table4-2-9.