

## FARMING SYSTEM RESEARCH PROJECT

Technical Programme



ICAR Research Complex for N. E. H. Region, ." Barapani, Meghalaya, INDIA

## FARMING SYSTEM RESEARCH PROJECT

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## PREFACE

ICAR Research Complex with its establishment in the year 1975 launched a multi-disciplinary project "Alternative Farming Systems to replace Jhuming". Agri-horti-silvipastoral land use model emerged as an alternative to shifting cultivation. Now there is need for in-depth studies on promising farming systems from various angles to assess the environmental impact of systems and their sustainability on steep slopes. There is scope in strengthening inter-institutional and interdisciplinary linkages to identify and resolve major constraints for sustainable farming system, Farming system Research Project at Barapani Farm is an effort in this direction. This bulletin embodies the technical programme and scope of study of the Farming System Research Project located at ICAR Research Complex, Barapani, Meghalava.

> R.N. PRASAD Director

## Farming System Research

## HISTORICAL BACKGROUND :

Environmental degradation in North Eastern Hill Region due to shifting cultivation has reached at an alarming point. With the establishment of ICAR Research Complex in the year 1975, a project entitled "Alternative Framing Systems to replace Jhuming" was launched at the Farm of Soil Conservation Training Institute, Byrnihat. A multi-disciplinary team initiated the work on three alternatives to shifting cultivation on 4 hectares of land offered by Soil Conservation Department. This was a time when ICAR Research Complex had no research farm of its own. Since beginning, the aim was to develop watershed based land use system with emphasis on proper utilization and management of local natural resources. The project was continued for 8 years at Byrnihat. Besides, large number of experiments were also conducted on other aspects of crop production, water management and resource development. The significant achievement of the research during this period was identification of "agri-horti-silvipastoral" model as alternative to shifting cultivation.

## PROJECT DURING VII PLAN:

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A full-fledged farming system research project was initiated at ICAR Research Complex, Barapani in the year 1983 taking the advantage of experiences gained at Byrnihat between 1975-82. Eight different watershed based farming systems consisting of livestock based land use (FS-W<sub>1</sub>), Forestry (FS-W<sub>2</sub>), Agroforestry land use (FS-W<sub>3</sub>), Agriculture (FS-W<sub>4</sub>), Agri-horti-silvipastoral land use (FS-W<sub>5</sub>), Horticulture land use (FS-W<sub>6</sub>), Natural fallow (FS-W<sub>7</sub>) and Shifting Cultivation land use (FS-W<sub>8</sub>) were installed. Besides, natural and cultivated pasture, silvi-pasture, agro-forestry are also being maintained

and evaluated. The brief description of the watersheds are given in table 1 while soil loss, peak flow and runoff during last six years are given in table 2. At present the plot FS-W<sub>8</sub> is planted with broom grass. Scientists from Soil Science, Agril. Engineering (Farm tools and implements and soil and water conservation), Agronomy, Horticulture, Animal Nutrition, Fishery, Plant Pathology, Entomology, Agril. Economics, Agril. Extension and Ecology are the participants. All systems are in their 7th year of evaluation and being maintained on latest available resource management and production technology aiming at maximising output. The results distinctly reveal that Agrihorti-silvipastoral livestock based farming system is in positive income group. It is also inferred that the problem of degradation of land and water resources can be tackled suitably through mixed land use systems on steep slope in micro-watershed.

#### Significant achievements:

Economically viable cropping system/livestocks were identified for each farming system (Table 3).

Contour bund and half moon terrace were found suitable control measures for soil/water erosion on steep slope where as bench terrace is more effective under mild slope situation. Contour bunded area got converted into bench terraces in 4-5 years period.

The model land use suggested as an alternative to jhuming in which slopes below 50% towards foot hills assigned to agricultural crops, slopes between 50-100% for horticulture and slopes over 100% used for forestry/silvi-pastoral crops.

Soil productivity can be maintained for sustained crop yields.

Over 90 to 100% of the total rainfall is retained in the watersheds.

Integration of livestock in the farming systems enhances the income, manure for soil health and family labour utilization.





Agro Forestry: Pineapple with Accassia auriculiformis and Alnus nepalensis

#### **PROJECTION DURING VIII PLAN:**

Soil erosion, declining fertility and loss of fauna and flora are adversely affecting the sustained productivity of the land. The first research effort in this direction was initiated in the year 1976 to provide the alternative for shifting cultivation. The promising farming system needs in-depth studies from different angles for their effective integration leading to the development of sustainable systems on hill slopes. Thus, the study during VIII Plan is targetted with the following objectives:

## 1.0 Evaluation and documentation of indigenous farming systems

- A. Characterization and identification:
  - i) Distribution of farming systems at different altitudes.
  - ii) Climate (rainfall, humidity, temperature/sunshine hours, physiography of hills, wind velocity)
- B. Monitoring of input /output in the systems
  - i) Use of seeds, fertilizers/manpower/pesticides etc.
  - ii) Improved breeds, balanced feeds, health management
  - iii) Gross and net returns
  - iv) Constraints.

C. Soil health:

- i) Effects on soil erosion/fertility build up (farmers view)
- ii) Laboratory investigation:
  - Fertility status: pH, organic carbon, available P, K, Ca, Mg, exch. Al and micro-nutrients.
  - Soil orthopodes
  - Microbial population

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2.0 Developing improved and sustainable farming systems for different altitude situations of North Eastern Hill Region:

A. Intensive evaluation of different farming systems towards sustainable production, integrated use of organics to increase efficiency of crop nutrients, economy in chemical fertilizers and maintenance of soil health. 1

- B. To assess the impact of farming systems on environment.
- C. Detailed evaluation of different farming systems with special reference to input and output relationship.

## MAJOR THRUST AREAS OF RESEARCH :

- 1.0 Hydrology, soil conservation and water management
- 1.1 Hydrological behaviour of watershed under different land uses/farming system :
  - Rainfall, runoff, base flow, and soil loss
  - Water yield and soil loss modelling including land use, soil conservation measures, watershed characteristics and rainfall
  - Rainfall intensity, erosion index, water yield relationships, probability analysis, unit hydrograph etc.
  - Sub-surface hydrology not studied is devolved

## 1.2 Water harvesting :

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- Water storage behaviour in seasonal pond
- Effect of land uses on different components of water yield of the pond

## 1.3 Soil conservation measures :

- Performance of bench terraces, contour bunds, trenches, half moon terraces, grassed water ways and their maintenance requirement
  - Effect of bench terrace, countour bund and contour trench on soil moisture losses on slopes and their effect on water movement

## 1.4 Water management :

- Effect of land uses on soil moisture pattern
- Effect of mixed land use system on sub-soil moisture use, water balance studies
  - Studies on techniques for monitoring soil and water movement in slopy land situation.

## 2.0 Soil fertility management :

- Fertility evaluation under different land uses
  - Effect of land use patterns and crops on nutrient dynamics in relation to sustained soil health and productivity.
- Use of farm wastes to increase efficiency of plant nutrients and economy in chemical fertilizers and amendments.
  - Microbial behaviour in relation to nutrient availability

## 3.0 Production and management :

- Maximising the crop production of various land uses
- Daily, weekly, monthly and seasonal input ouput details for crop-plant and livestock production
- Energy management and mechanisation
- Availability of by-products and their utilization through subsidiary enterprises in different farming systems
- Processing techniques for value addition in produce and products

## 4.0 Livestock management :

- Assessment of availability of feed, fodder and byproducts from different farming systems
- Utilization of feed, fodder and by-products for livestock production as subsidiary source of income in different farming systems
- Input and output details including organic manure supply as complementary to soil health maintenance

## 5.0 Plant protection :

- Disease-pest-host in natural and agro-ecosystems
- Distribution of pathogens and pests in time and space
- Monitoring the intensity of diseases and pests in different eco-systems/cropping systems and their individual/ cumulative damages
- Dynamics of disease and pest build-up
- Defence of sole and mixed plant populations against disease and pests
- Pollution hazards due to use of pesticides





Agri-Horti-Silvi pastoral and Horticultural Farming System including Water harvesting pond

### 6.0 Pisciculture:

- Assessment of supplementary income from pisciculture on micro-watershed based ponds.
- Increasing efficacy of agri-based wastes and by-products in fish production.

# 7.0 Ecological aspect:

- Monitoring of microbial structure of the rhizosphere and their interaction with plant genotypes in each farming system.
- Developing model for predicting total ecological impact on hill agriculture.

### 8.0 Economy:

----- Evaluation of economic potentiality of each farming system.

## 9.0 Extension: TO A STATE AT A TO A STATE OF WORL

 Monitoring of constraints for the adoption of best land use model amongst the farmers. 3.0 Testing of the appropriate and sustainable farming systems through Operational Research Project and On Farm Research with a whole village approach.

Participating scientists prepare yearwise technical programme considering the major thrust areas in his/her field of specialization. Prior to initiating the study, technical programme are discussed amongst the working group of the Farming System Research Project (FSRP).

### WHO CAN BE ASSOCIATED:

Scientists, students, foresters, environmentalists, ecologists of National and International research organisations / Universities can be associated with the project to identify and resolve major constraints for sustainable farming systems.

#### HOW TO ASSOCIATE WITH THE PROJECT ?

Project Leader of the FSRP can be approached for becoming a participant. He/she should submit brief technical programme with time frame alongwith objectives for his perusal and consideration. TABLE 1 : DESCRIPTION OF MICRO-WATERSHED

	and the second se	A		and the second s				
Particular	FS-W <sub>1</sub>	FS-W <sub>2</sub>	FS-W <sub>3</sub>	FS-W <sub>4</sub>	FS-W <sub>5</sub>	FS-W <sub>6</sub>	FS-W <sub>7</sub>	FS-W <sub>8</sub>
Fotal area (ha) Forest land (ha)	1.39 0.45	3.89 3.05	2.94 2.05	0.64 0.06	1.58 0.55	3.13 2.17	1.03 0.08	0.52 . 0.02
Area under planed land use (ha) Average slope (%) Soil type*	0.95 32.02 cl-sicl	0.84 38.00 cl-sicl	0.90 32.18 cl-sicl	0.58 32.42 cl-sicl	1.03 41.77 cl-sicl	0.96 53.18 cl-sicl	0.95 45.87 cl-sicl	0.50 41.35 cl-sicl
Dominent Land use pattern	Livestock based	Forestry	Agro- forestry	Agri- culture	Agri- horti- silvi- pastoral	Horti- culture	Natural fallow	Broom grass
Conservation measures	contour bunds, trench and grassed waterways		contour bunds	contour bunds, bench terrace & grassed waterways	contour bunds, bench terrace, grassed waterway half moo	same as W <sub>5</sub> <i>j</i> s & on		contour bunds
Input output ratio	1:1.19	-	W In	1:0.82	1:2.03	1:0.54		-

\* Soil survey manual

TABLE 2: Effect of land use pattern on runoff, peak flow and soil loss in different watersheds •

Raintall (mm)     W1     W2     W3     W4     W5     W6       1983     P     2247     39.09     16.94     6.17     31.86     10.45     8.16       5     S     Nii     N	and the second se		No. November of a particular and						
R     27.23     53.98     10.50     25.01     4.10     6.42       1983     P     2247     39.09     16.94     6.17     31.86     10.45     8.16       R     Nii	Rainfall (mm)	W1	W2	W3	W4	W5	W6	W7	W8
	R	27.23	53.98	10.50	25.01	4.10	6.42	2.86	15.88
S     NII     NI     NI<	1983 P 2247	39.09	16.94	6.17	31.86	10.45	8.16	13.65	35.30
R     Nil     48.84     10.71     4.99     0.24     9.28       1984     2195     Nil     0.89     1.42     2.68     0.19     2.34       S     Nil     Nil     Nil     Nil     Nil     0.19     2.34       1985     P     2134     1.97     9.13     12.87     2.071     5.38     11.04       1985     P     2234     1.97     9.13     12.87     20.71     5.33     11.04       S     Trace     7.80     0.35     0.077     0.12     0.19     0.33       1986     P     2339     12.87     3.81     0.38     0.19     0.33       1986     P     2706     0.12     3.87     3.81     0.38     0.19     0.33       1987     P     2706     0.38     5.94     11.88     4.51     8.65     4.00       S     Trace     Trace     Trace     Trace     Trace     1.865     4.00     0.33       S	S	Nil	Nil	liN .	liN	Nil	liN	liN	IIN
1984 P   2195   Nii   0.89   1.42   2.68   0.19   2.34     S   Nii   Nii   Nii   Nii   0.15   Trace   0.37     B   0.75   46.26   34.66   11.76   5.98   11.04     1985 P   2234   1.97   9.13   12.87   20.71   5.33   11.40     S   Trace   7.80   0.35   0.07   0.12   3.81   0.090   6.82     1986 P   2309   0.12   3.87   3.81   0.38   11.96   0.19   0.33     1986 P   2309   0.12   3.87   3.81   0.38   0.90   0.12     S   Trace   Trace   Trace   0.38   0.09   6.82   0.19     1987 P   2706   0.18   2.33   11.88   4.51   8.65   4.00     S   7106   0.38   5.94   11.88   4.51   8.65   4.00     S   7706   0.33   5.735   109.08   0.33   5.735   109.08     S	R	Nil	48.84	10.71	4.99	0.24	9.28	0.01	32.57
S     Nii     Nii     Nii     0.15     Trace     0.37       R     0.75     46.26     34.66     11.76     5.98     11.04       1985     2234     1.97     9.13     12.87     20.71     5.33     11.40       S     Trace     7.80     0.35     0.07     0.12     0.19       R     0.65     44.61     27.33     7.64     2.33     11.40       S     Trace     7.80     0.35     0.07     0.12     0.19       I     0.65     44.61     27.33     7.64     2.33     11.98       S     Trace     Trace     Trace     0.12     3.81     0.38     0.99     6.82       S     Trace     Trace     Trace     Trace     Trace     0.38     6.63     6.11     6.41       I     8.30     0.23     6.63     6.11     Ni     Ni     Ni       I     2324     11.88     4.51     8.65     4.00     8.65 <td< td=""><td>1984 P 2195</td><td>Nil</td><td>0.89</td><td>1.42</td><td>2.68</td><td>0.19</td><td>2.34</td><td>0.06</td><td>19.22</td></td<>	1984 P 2195	Nil	0.89	1.42	2.68	0.19	2.34	0.06	19.22
R $0.75$ $46.26$ $34.66$ $11.76$ $5.98$ $11.04$ $1985$ $2234$ $1.97$ $9.13$ $12.87$ $20.71$ $5.33$ $11.40$ STrace $7.80$ $0.35$ $0.07$ $0.12$ $0.19$ R $0.65$ $44.61$ $27.33$ $7.64$ $2.33$ $11.98$ $1986$ $2309$ $0.12$ $3.87$ $3.81$ $0.38$ $0.07$ $0.12$ STraceTraceTraceTrace $0.38$ $0.90$ $6.82$ $1987$ $2706$ $0.38$ $5.94$ $11.88$ $4.51$ $8.65$ $4.00$ $1987$ $2706$ $0.38$ $5.94$ $11.88$ $4.51$ $8.65$ $4.00$ $1987$ $2706$ $0.38$ $5.94$ $11.88$ $4.51$ $8.65$ $4.00$ $1987$ $2706$ $0.38$ $5.94$ $11.88$ $4.51$ $8.65$ $4.00$ $1988$ $8$ $3324$ $7.80$ $9.85$ $5.26$ $6.03$ $0.03$ $1988$ $8$ $3324$ $7.80$ $9.85$ $5.26$ $6.37$ $1989$ $8$ $3324$ $7.14$ $6.08$ $5.23$ $6.37$ $1989$ $7$ $10.78$ $7.14$ $6.63$ $6.37$ $1989$ $7$ $9.85$ $7.14$ $6.63$ $6.37$ $1989$ $7$ $9.96$ $7.14$ $6.63$ $6.37$ $1989$ $7$ $7.14$ $6.63$ $5.15$ $6.37$ $1989$ $9.16$ $7.14$ $6.63$ $5$	S	Nil	Nil	Nil	0.15	Trace	0.37	Nil	3.71
1985     2     2234     1.97     9.13     12.87     20.71     5.33     11.40       S     Trace     7.80     0.35     0.07     0.12     0.19       R     0.65     44.61     27.33     7.64     2.33     11.98       1986     P     2309     0.12     3.87     3.81     0.35     0.01     0.19       S     Trace     Trace     Trace     Trace     0.38     0.90     6.82       1987     P     2706     0.33     5.94     11.88     4.51     8.65     4.00       S     Nil     Nil     Nil     Nil     Nil     Nil     Nil     Nil     11.95       1987     P     2706     0.33     5.94     11.88     4.51     8.65     4.00       S     2706     0.33     5.94     11.88     4.51     8.65     4.00       R     43.97     239.86     105.49     48.88     57.35     109.08       S     16	R	0.75	46.26	34.66	11.76	5.98	11.04	0.79	35.74
S     Trace     7.80     0.35     0.07     0.12     0.19       R     0.65     44.61     27.33     7.64     2.33     11.98       1986     2309     0.12     3.87     3.81     0.38     0.90     6.82       S     Trace     Trace     Trace     Trace     0.23     44.28     0.973     6.63     6.11     6.82       1987     P     2706     0.38     5.94     11.88     4.51     8.65     4.00       S     Nil     Nil <td< td=""><td>1985 P 2234</td><td>1.97</td><td>9.13</td><td>12.87</td><td>20.71</td><td>5.33</td><td>11.40</td><td>3.26</td><td>86.10</td></td<>	1985 P 2234	1.97	9.13	12.87	20.71	5.33	11.40	3.26	86.10
R     0.65     44.61     27.33     7.64     2.33     11.98       1986     2309     0.12     3.87     3.81     0.38     0.90     6.82       S     Trace     Trace     Trace     Trace     0.01     0.33       I987     P     2706     0.38     5.94     11.88     4.51     8.65     4.00       S     0.23     44.28     29.73     6.63     6.11     6.33       1987     P     2706     0.38     5.94     11.88     4.51     8.65     4.00       S     Nil     Nil     Nil     Nil     Nil     Nil     Nil       1988     P     3324     7.81     7.80     9.85     5.735     109.08       1988     P     3324     7.81     7.80     9.85     5.735     109.08       S     0.16     0.07     0.07     0.07     0.03     1.22     4.37       S     16.24     8.3.97     60.88     58.67	S	Trace	7.80	0.35	0.07	0.12	0.19	0.05	0.44
1986 P   2309   0.12   3.87   3.81   0.38   0.90   6.82     R   Trace   Trace   Trace   Trace   0.11   0.33     I987 P   2706   0.23   44.28   29.73   6.63   6.11   6.41     S   Nil   Nil   Nil   Nil   Nil   Nil   Nil   0.33     1987 P   2706   0.38   5.94   11.88   4.51   8.65   4.00     S   Nil   Nil   Nil   Nil   Nil   Nil   Nil   Nil     1988 P   3324   7.81   7.80   9.85   5.26   5.09   0.03     1988 P   3324   7.81   7.80   9.85   5.69   0.03   0.03     S   0.16   0.07   0.07   0.07   0.33   1.22   4.37     I989 P   3324   7.81   7.08   5.27   108.80     S   0.16   0.33   1.22   5.69   0.03     I989 P   3.47   4.94   7.14   6.63   6.13	R	0.65	44.61	27.33	7.64	2.33	11.98	8.66	I
S   Trace   Trace   Trace   Trace   Trace   0.03   44.28   29.73   6.63   6.11   6.41   6.41     1987   P   2706   0.38   5.94   11.88   4.51   8.65   4.00     S   Nii   Nii   Nii   Nii   Nii   Nii   Nii   Nii     1988   P   3324   7.81   7.80   9.85   5.26   4.00     S   Nii   Nii   Nii   Nii   Nii   Nii   Nii     1988   P   3324   7.81   7.80   9.85   5.26   5.69   0.03     S   0.16   0.07   0.07   0.03   1.22   4.37     I989   P   3.47   4.94   7.14   6.63   5.15   6.37     I989   P   3.47   4.94   7.14   6.63   5.15   6.37     I989   P   3.47   4.94   7.14   6.63   6.37   6.37     S   Ni   Ni   Ni   Ni   7.49   6.37	1986 P 2309	0.12	3.87	3.81	0.38	06.0	6.82	1.20	I.
R     0.23     44.28     29.73     6.63     6.11     6.41       1987     P     2706     0.38     5.94     11.88     4.51     8.65     4.00       S     Nil     Nil     Nil     Nil     Nil     Nil     Nil     Nil       I987     P     2706     0.38     5.94     11.88     4.51     8.65     4.00       S     Nil     Nil     Nil     Nil     Nil     Nil     Nil       1988     P     3324     7.81     7.80     9.85     5.26     5.09     0.03       1989     P     3324     7.81     7.80     9.85     5.26     4.37       1989     P     3.47     4.94     7.14     6.63     5.15     108.80       1989     P     3.47     4.94     7.14     6.63     5.15     6.37       1989     P     3.47     4.94     7.14     6.63     5.15     6.37       1989     P     Mil </td <td>S</td> <td>Trace</td> <td>Trace</td> <td>Trace</td> <td>Trace</td> <td>0.01</td> <td>0.33</td> <td>Trace</td> <td>I</td>	S	Trace	Trace	Trace	Trace	0.01	0.33	Trace	I
1987   P   2706   0.38   5.94   11.88   4.51   8.65   4.00     S   Nii   Nii   Nii   Nii   Nii   Nii   Nii   Nii     R   43.97   239.86   105.49   48.88   57.35   109.08     1988   P   3324   7.81   7.80   9.85   5.26   5.69   0.03     S   0.16   0.07   0.07   0.03   1.22   4.37     R   16.24   83.97   60.88   58.67   5.27   108.80     1989   P   3.47   4.94   7.14   6.63   5.15   6.37     1989   P   3.47   4.94   7.14   6.63   5.15   6.37     Nii   Nii   Nii   Nii   7.14   6.63   6.03   6.37	R	0.23	44.28	29.73	6.63	6.11	6.41	1.99	19.84
S     Nil	1987 P 2706	0.38	5.94	11.88	4.51	8.65	4.00	2.66	8.88
R 43.97 239.86 105.49 48.88 57.35 109.08   1988 P 3324 7.81 7.80 9.85 5.26 5.69 0.03   S 0.16 0.07 0.07 0.33 1.22 4.37   R 16.24 83.97 60.88 58.67 5.27 108.80   1989 P 3.47 4.94 7.14 6.63 5.15 6.37   S Nil Nil Nil Nil Nil 8.03	S	Nil	Nil	Nil	IIN	Nil	Nil	IIN	Nil
1988 P 3324 7.81 7.80 9.85 5.26 5.69 0.03   S 0.16 0.07 0.07 0.03 1.22 4.37   R 16.24 83.97 60.88 58.67 5.27 108.80   1989 P 3.47 4.94 7.14 6.63 5.15 6.37   S Nil Nil Nil Nil Trace 0.04 8.03	R	43.97	239.86	105.49	48.88	57.35	109.08	51.22	517.72
S     0.16     0.07     0.03     1.22     4.37       R     16.24     83.97     60.88     58.67     5.27     108.80       1989 P     3.47     4.94     7.14     6.63     5.15     6.37       S     Nil     Nil     Nil     Nil     Trace     0.04     8.03	1988 P 3324	7.81	7.80	9.85	5.26	5.69	0.03	4.49	26.52
R     16.24     83.97     60.88     58.67     5.27     108.80       1989     P     3.47     4.94     7.14     6.63     5.15     6.37       S     Nil     Nil     Nil     Trace     0.04     8.03	S	0.16	0.07	0.07	0.33	1.22	4.37	Nil	0.24
1989 P     3.47     4.94     7.14     6.63     5.15     6.37       S     Nil     Nil     Nil     Trace     0.04     8.03	R	16.24	83.97	60.88	58.67	5.27	108.80	15.57	19572
S Nil Nil Trace 0.04 8.03	1989 P	3.47	4.94	7.14	6.63	5.15	6.37	2.01	16.87
	S	Nil	Nil	Nil	Trace	0.04	8.03	IIN	Trace
				11.0	1 4 1				

R - Runoff (mm); P - Peak Flow (mm ha -1); S - Soil loss (t ha-1,)

Particulars	Cropping System	Livestock
W <sub>1</sub>	Maize, Ricebean, Oat, Pea, Setaria, Guinea, Broom Grass, Tapioca, Bajra, Sweet Potato and Fodder tree of Ficus hokkerii (Nevaro).	Cows – 2 with their two fol- lowers Pig – 2 Rabbits – 10
W <sub>2</sub>	Wattle, Alder Exbucklandia, Albizia lebbeck, Acacia auriculiformis, Titachampa.	
$W_3$	Cherry, Exbucklandia, Guava,	Goat – 8
	Pineapple on contour bund, Beans in interspaces and French bean.	Rabbits –10
W <sub>4</sub>	Paddy, radish/turnip/rajmash, Maize Groundnut, French Bean/Rajmash, Ginger, Turmeric and Oat. Setaria and Guinea on risers.	Cow – 1 with one of her fol- lowers
W <sub>5</sub>	French bean, Ricebean, Radish, Sweet potato, Turmeric, Ginger, Guava, Khasi mandarin, Assam lemon, Pineapple, Stylo, Setaria, Guinea grass, Broom grass, Alder, Exbucklandia and <i>Ficus hookerii</i> .	Pig – 10 Goat – 8
. W <sub>6</sub>	Peach, Pear, Citrus, Guava, Ginger, setaria (on risers), Bean in interspaces, Cowpea, Ricebean, Radish, Turnip.	
W <sub>7</sub>	Natural fallow	
W <sub>8</sub>	Abandoned jhumland/broom grass	Goat – 8

Table 3. Economically viable cropping systems and livestock

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