

# Pan formation in soils under paddy-potato/mustard-paddy system in Indo-Gangetic Plains, West Bengal

T. Bhattacharyya, S.K. Ray, A.K. Sahoo, S.L. Durge, P. Chandran, D. Sarkar and D.K. Pal.

Division of Soil Resource Studies, National Bureau of Soil Survey and Land Use Planning, Amravati Road, Nagpur - 400 010, India

The soils of Bardhaman district in West Bengal are traditionally used for growing paddy. Potato and mustard (Figs. 1 to 3) have been introduced in the cropping system for quite some time. Availability of plenty of irrigation water has made the rabi crops (potato, mustard) and summer rice (*boro*) (Fig. 4) very popular in this belt.

The general level of management for paddy and potato is high. These management practices involve use of modern farm machineries, hybrid seeds, fertilization and plant protection measures (Table 1). During the examination of typical soil profile of Konarpara series, a hard pan below the surface ploughed layer was observed (Fig. 5). Formation of this relatively hard pan has been found to be common in other benchmark soil series such as Hangram, Sasanga and Madhpur in Bardhaman district. This pan layer is limited to 10-25 cm width and are generally loamy in texture with varying amount of fine and coarse sand. The bulk density (BD) of soil samples determined by core method clearly indicate an increase in the BD values in second layer (Table 3). The increase of B.D. over surface is found to be maximum in the layer immediately below the surface horizon (Fig. 6) indicating pan formation due to continuous use of heavy farm machinery for field preparation. Although the present level of management helping in the formation of an aerobic (potato/mustard) and anaerobic (paddy) pedo-environment is giving appreciable yield for all the crops, the progress of pan formation may render these soils more non-porous and hard much to the inconvenience of better tuber growth. This is in spite of the fact that potato is grown in ridges. However the trend of alkaline pH of irrigation water could also be a signal for the initiation of soil degradation due to indiscriminate use of groundwater (Tables 1 & 2). The present management system is fraught with ill effect of mechanised farming and this may increase with time bringing negative impact in sustaining agricultural productivity of lands in the Gangetic west Bengal in terms of both physical and chemical degradation of soils.

Table 1. Level of management for potato, mustard and paddy.

| Crop  | Tillage practice (No. of times) | Seed rate (Kg/ha) | Sowing time (week)   | Harvesting time (week) | No. of investigations | Method of sowing | Fertilizer dose (Kg/ha)  | Plant protection measures              | Yield Q/ha |
|---|---------------------------------|-------------------|----------------------|------------------------|-----------------------|------------------|--|--|------------|
| <b>Madhpur, Bhatar, Bardhaman district, West Bengal</b>       |                                 |                   |                      |                        |                       |                  |  |  |            |
| Paddy (Kharif)  | Bullock (4-5)<br>Tractor (2)    | 42-45             | July (1)             | Nov (2)<br>Dec (2)     | Nil                   | Line             | Urea 90-100, SP-65<br>DAP-65<br>MP-65  | Measures taken against virus and pests | 30-40      |
| Mustard   | Bullock (4-5)<br>Tractor (2)    | 10                | Nov (4)<br>Dec (4)   | Feb (2)                | 4-5 <sup>1</sup>      | Line             | Urea-250,SP-48<br>10:26-240-320  | Pesticides and herbicides used         | 9-10       |
| Potato  | Bullock (4-5)<br>Tractor (2)    | 1500-1800         | Nov (4)              | Feb (2)                | 5-6 <sup>1</sup>      | Line             | Urea-420-450,<br>Micronutrient<br>10:26:26-120-150                                 | Pesticides and herbicides used         | 240-260    |
| Paddy (Boro)  | Bullock (4-5)<br>Tractor (2)    | 95-100            | Feb (2)              | April (4)<br>May (2)   | 24-25 <sup>2</sup>    | Line             | Urea-130, SP-130-150<br>DAP-130<br>MP-90-100                                       | Pesticides and herbicides used         | 48-50      |
| <b>Konarpara, Shaktigarh, Bardhaman district, West Bengal</b> |                                 |                   |                      |                        |                       |                  |  |  |            |
| Paddy (Kharif)  | Bullock (4-5)<br>Tractor (5)    | 65                | June (4)             | Nov (2)                | Nil                   | Line             | Urea-130, MP-60-70<br>10:26:26-65-70,<br>Sulphur-0.6-0.8 <sup>3</sup><br>DAP-70-90 | Pesticides used                        | 50-65      |
| Mustard   | Bullock (4-5)<br>Tractor (5)    | 13                | Nov (2)              | Feb (2)                | 4-5                   | Line             | Urea-130-140,<br>sulphur-0.6-0.8 <sup>3</sup><br>MP-300<br>DAP-250                 | Pesticides used                        | 8-10       |
| Potato  | Bullock (4-5)<br>Tractor (5)    | 1600-1700         | Nov (2)              | Jan (4)<br>Feb (1)     | 5-6                   | Line             | Urea-130-140, MP-300<br>10:26:26-300<br>DAP-300                                    | Pesticides used                        | 380-420    |
| Paddy (Boro)  | Bullock (4-5)<br>Tractor (5)    | 92-95             | Feb (2)<br>March (2) | May (2)<br>June (2)    | 24-25                 | Line             | Urea-65-70<br>DAP-92-95<br>MP-130-140  | Pesticides used                        | 69-85      |

1 – every 10-15 days and as and when necessary

2 – two irrigations for a week for 3 months

3 – micronutrients are also applied by progressive farmers

Table 2. Bulk density of representative soils collected in the field

| Depth (cm)  | BD (Mg m <sup>-3</sup> ) | Increase of BD over surface (%) | Water pH* | EC of water* |
|---|--------------------------|---------------------------------|-----------|--------------|
| Madhpur, Bhatar, Barddhaman district, West Bengal       |                          |                                 |           |              |
| 0-9   | 1.57                     | 0                               | 8.0       | 0.4          |
| 9-27  | 2.04                     | 30                              |           |              |
| 27-44   | 1.83                     | 16                              |           |              |
| 44-56   | 1.84                     | 16                              |           |              |
| 56-80   | 1.84                     | 16                              |           |              |
| 80-99   | 1.88                     | 20                              |           |              |
| 99-109  | 1.85                     | 18                              |           |              |
| 109-150   | 1.91                     | 22                              |           |              |
| Konarpara, Shaktigarh, Barddhaman district, West Bengal |                          |                                 |           |              |
| 0-9   | 1.44                     | 0                               | 8.2       | 0.3          |
| 9-19  | 1.79                     | 24                              |           |              |
| 19-31   | 1.77                     | 23                              |           |              |
| 31-49   | 1.67                     | 16                              |           |              |
| 49-71   | 1.65                     | 15                              |           |              |
| 71-104  | 1.67                     | 16                              |           |              |
| 104-130   | 1.71                     | 19                              |           |              |
| 130-150   | 1.77                     | 22                              |           |              |

\* Water used for irrigation



Fig. 4. Seed Bed Ready for Boro paddy transplantation (20.1.2004)  
(Village Madhpur, P.S. Khandoghosh)

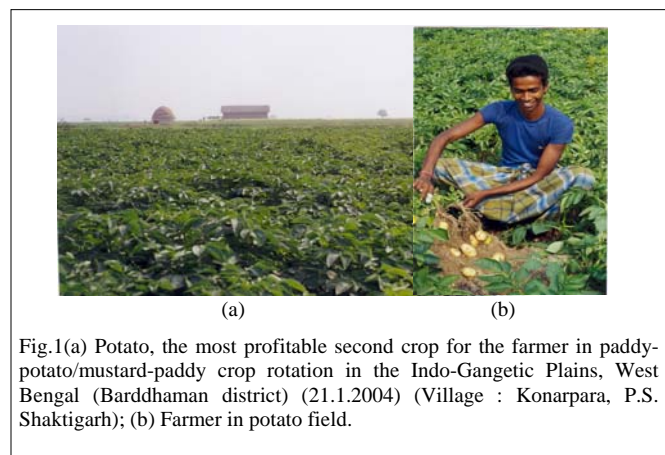


Fig.1(a) Potato, the most profitable second crop for the farmer in paddy-potato/mustard-paddy crop rotation in the Indo-Gangetic Plains, West Bengal (Barddhaman district) (21.1.2004) (Village : Konarpara, P.S. Shaktigarh); (b) Farmer in potato field.

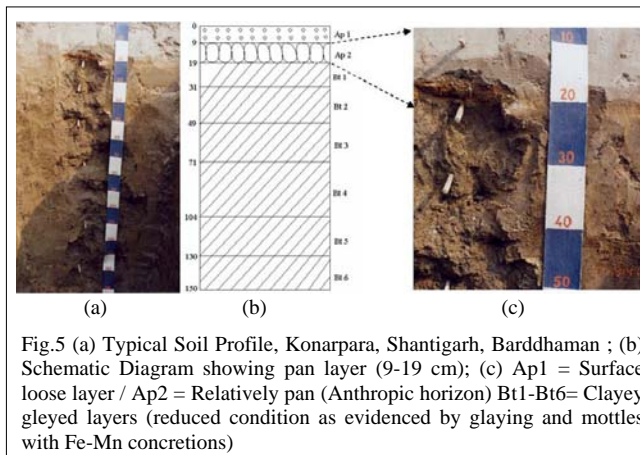


Fig.5 (a) Typical Soil Profile, Konarpara, Shantigarh, Barddhaman ; (b) Schematic Diagram showing pan layer (9-19 cm); (c) Ap1 = Surface loose layer / Ap2 = Relatively pan (Anthropic horizon) Bt1-Bt6= Clayey gleyed layers (reduced condition as evidenced by gleying and mottles with Fe-Mn concretions)



Fig. 2. Mustard, the important second crop in crop rotation (20.1.2004)  
(Village Madhpur; P.S. Khandoghosh)



Fig. 3. Shallow tubewell – source of groundwater from 30-50 ft

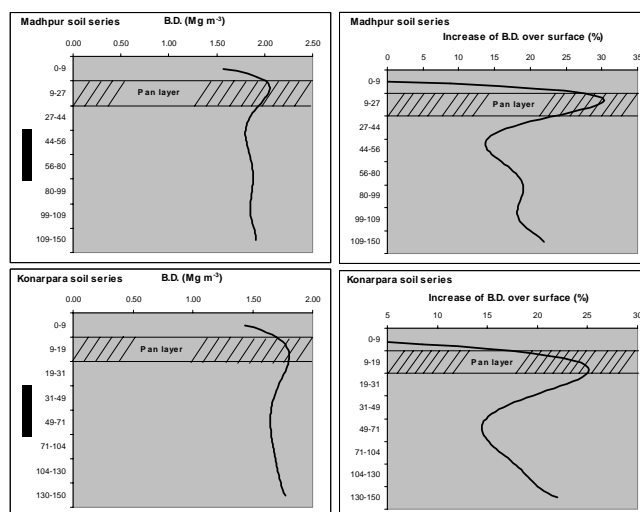


Fig.6 Increase in Bulk Density in the pan layer immediately below the surface horizon