APPENDIX I: Documentation of the Iron Smelting Process as practiced by the Asur- Birjhia tribes at Bishunpur
During my field survey in the Ranchi district I have documented the indigenous iron smelting activities of the Asura-Bhirjia tribes, organized by the Vikas Bharti at Bishunpur. The detailed documentation has been summarized below.

There were three persons involved in the smelting process. The furnace was 70 cm in height whereas the internal length of the same is about 83 cm. It tapered from below upwards with a hole at the top (13 cm in diameter) for pouring the charcoal and the ore. This hole extends to the bottom of the furnace. The hole in the bottom has a diameter of 32 cm. In the first stage, a mixture of ash, charcoal dust and rice husk was prepared. It was then filtered and some water was added to this mixture. By inserting this into the hole at the bottom a clay lining was prepared. Simultaneously iron ore was crushed into small pieces by another person. After that, a mud tuyere about 16 cm in length was placed in the middle of the hole at an angle of 15° to 20° with the floor. The rest of the hole was then filled with the said clay mixture. Some water was subsequently sprinkled to make that clay lining smooth. The furnace was then filled with charcoal added from the top. A machine-made blow-pipe was fixed in front of the tuyere. After half an hour of such pre-working preparation, fire was lit through a charcoal piece and with the help of the blow pipe the firing was gradually intensified. The blowing continued throughout the smelting procedure (49 blow-strokes/minute except the consolidation/last stage when the rate of blow-stroke is slightly higher). After 10 minutes, blue flame could be observed from the top of the furnace. About 300 gm of iron ore was then added from the top. This added iron ore slowly goes down. After 20-21 minutes some more charcoal (about 750 gm) and iron ore (about 300 gm) were added. Again after 12-13 minutes, same amount of charcoal and iron ore was added from the top. Similar process was performed during the entire smelting operation for 11-12 times. After one and half hour of working process (i.e., addition of charcoal and iron ore for five times), a hole was pierced in the clay lining at the bottom of the furnace to examine whether slag has formed. The result was negative. Finally, after two and a half hours of smelting operation (i.e., addition of charcoal and iron ore for 8 times), small amount of molten slag had come out of this temporary hole. After four hours of rigorous working, the supply of ore and fuel from the top was completely stopped. They worked the bellows with extra vigour for 10-12 minutes before the conclusion of the process. The clay lining was then broken down and the smelted material was taken out. Unfortunately, the smelters did not perform the subsequent process of reheating and hammering of the smelted materials. As a result, what was extracted was not pure iron. Moreover, the smelters also assumed that due to the use of machine-made bellows the temperature inside the furnace did not rise above 1000° to 1100° C. Thus, it is quite
probable, that due to mixing of slags and iron, the iron ingot produced was of very impure quality.

Basically, foot-operating bellows were more useful since the process of air blowing inside the furnace could be manually controlled or manipulated at every step of smelting. As a result the temperature could be controlled for different chemical reactions inside the furnace. Leuva in his works on Asuras pointed out the same (Leuva 1963:149). According to him, the most important apparatus used by the traditional Asurs was foot-bellows. Such bellow had three essential parts- a very solid wooden bowl, two bamboo blow-pipes which are fitted to the earthen nozzle in actual contact with the fire place and the raw cowhide covering the wooden bowl. Interestingly, it is also evident that sometimes two men were employed for operating the bellows. Buchanan in his report mentions that “Occasionally another man stands behind, rests his heel on the edge of the bellows, and presses the leather down with his toes at the same time with the other man. These bellows give a good deal off wind…”(Buchanan (1810-1811/1930: 16). It is also quite interesting that, during the comparison of operating parameters of Jiragora and Bishunpur iron making furnaces in 1991, Prakash highlighted that blowing rate was not consistent at the Bishunpur furnace and it varies from 40-50 strokes/minute at preheating stage (550° C) through 60-70 strokes/minute at the reduction stage (950° C) to 110 strokes/ minute at the consolidation stage (1500° C) (Prakash 1991: 359). During that time, foot operating bellows were used. Moreover, after the removal of the smelted materials, proper reheating and hammering processes were conducted resulting in the extraction of at least 95 % pure iron ingot.
The furnace

Preparation of clay mixture

Iron ore has been crushed into small pieces

Tuyere has been placed in the middle of the hole at an angle of 15° to 20° from the floor

Making of clay lining

Charcoal was put in the hole from the top

A machine-made blow pipe is fixed in front of the tuyere
Fire was lit through a charcoal piece

With the help of the blow pipe the firing was gradually intensified. The blowing continued throughout the smelting procedure.

Iron ore and charcoal have been added.

Molten slag had come out from the temporary hole.

Clay lining was broken down and smelted materials had been taken out.