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Dry Farming in the Practices of the Kalibangans

C. Mamatamayee
172, The Mall Aparts, Mall Road, Delhi 110 054, India

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ABSTRACT The prestine Kalibangans gathered berries for food, plough cultivated legumes for fodder, and sickle- gathered barley grass for fuel and other uses prior to the arrival of the Harappans. Irrigation had no place in gathering. Gathering of barley grass transformed to dry cultivation of the cereal when dehiscent seeds of the grass transformed to indehiscent seeds of the cereal due to repeated defoliation during urbanization of the place. The habitat was rich enough in soil water to enable growth of the cereal without irrigation.

INTRODUCTION

The practice of farming in Kalibangan is attested by excavation of a ploughed field (IAR, 1968-69; Lal, 1971). The field was ploughed by prehistoric Kalibangans of Period - I who were antecedent to the people of Period - II representing the Indus Valley (Harappan) culture. The field was a part of the levee configuration located between the levee mount KLB-1 in the west and the mount KLB-2 in the east. The Period - I people were settled on KLB-1 while KLB-2 was the main residential area of the Harappans. One of the distinct feature of Period-I was the practice of dry farming, namely of barley. Dry farming is rainfed unlike irrigation farming which depends on artificial water supply by humans. Dry farming in Kalibangan continued during Period-II, dinstinguished from irrigation farming of cereals by contemporary people of the Indus Valley. Conjecture of dry farming is based on necessary ecological relations of the crops in use of the Kalibangans and actuation of these relations in their habitat. Selective farming of berries, legumes and grasses for food, fodder and fuel transformed to their cultivation when barley grass transformed to a cereal in late level of occupation in Kalibangan.

THE FIELD CROPS OF KALIBANGAN

The excavated field was ploughed to make criss cross furrows. The purpose of this system of farming is known from its anology with the present. Farmers of the surrounding villages make similar furrows for intercropping of horse gram and mustard, suggesting that the field was ploughed for these crops (IAR, 1968-69; Lal, 1971). The texa included in these crops are laterally spreading or erect herbaceous annual legumes which tend to appear as weeds in a crop of cereals. The crop requires minimum preparation and care during its growth. It is often harvested using sickles, as it must have been in Kalibangan when the field was ploughed.

From the system of farming the analogy can be extended to use of these crops in the prehistoric past. The analogy suggests that the field was ploughed to cultivate crops for fodder. Horse gram is primarily a fodder crop though its seeds may be used as a whole grain *dal* among the poor, specially in southern India (Wol, 1959; Kochhar, 1981). Mustard is raised as a crop of oil seeds but its young leaves may be eaten as a green vegetable. The residue left after crushing the seeds and the plants in their entire make nitrogen rich animal feed. Use of small earthen pots with narrow mouths in fabric A of Period I (IAR, 1962-63; Thapar,

1975,1979) could have been used by the Kalibangans for storing oil (Manchanda, 1972). They could have used their stone querns and mullers for crushing the oil seeds but the recovery would have been very small making mustard predominatly a crop for fodder. The fodder crops were harvested from ploughed fields when food of cereals was not in use of the Kalibangans.

The food crops in use of the Kalibangans included banana, date, *ber* (Jujube) and cucurbits, namely melons, cultivated by them prior to fodder cultivation. The texa of the food crops included berry-bearing perannial or annual trees or herbs. Use of banana is inferred from a motif on a piece of pottery of Period I (Thapar, 1975, 1979; Asthana, 1985). Use of other berries is attested by excavation of kerncis of these fruits from the archeaological remains of Kalibangan (IAR, 1962-63). These fruits were in use and domesticated in the entire geographical range of the species (Harlan, 1976) which included the Indus Valley (Allchin, 1979) and Kalibangan. The fruits could be eaten raw necessitated by absence of cooking ovens and vessels (Sauer, 1952, 1969; Blake, 1970) as they were in Kalibangan in absence of ovens which were not in their use till middle level of Period I (Thapar, 1975, 1979, 1985; Lal and Thapar, 1967). The dishes-and bowels-on-stand in use of the Kalibangans could have been their tableware for serving fruits (Manchanda, 1972). The berries were gathered from multiple purpose plants enabling survival of the pristine gatherers (Blake, 1970), specially of those living in spatial isolation, as in Kalibangan (Mamatamayee, 1991a, 1992d).

The Kalibangans of Period-I did not have cereals but were using cereal like grasses whose pollens have been identified. The pollens include several thousand charred grains of hulled barley, 50 grains of naked barley, one seed of *Pisum arvence* (field pea), one seed of *Cicer arietinum* (Bengal gram/chick pea/*Chana*) excavated from a depth of 2.5m (IAR, 1972-73; 1974-75). The cereal like grass of barley and the legumes of *chana* and peas were unpalatable to humans but were grazed by cattle of the pastoralists of Kalibangans in the period preceding the mud-brick building phase of Period-I (Mamatamayee, 1992b). Charring of the pollens could have been the result of some forest fire but would have concentrated the remains to a patch. Dispersal of the remains (Vishnu-Mitre and Savathri, 1982) suggest that the pollens were burnt when the flower bearing spikes were in use. The grasses could be used to make wattle huts or household furniture. They were essentially used to lit fire for roasting food or for keeping off chill while herding animals in open in winters and to fire earthen pots during ceramic phase of the early Kalibangans. Charred remains of cereal grasses in the neolithic pottery at Jamro suggests similar use of grass in the Mesopotamian valley and was the cause of the origin of barley in that region in the 7th millenium B.C. (Helbaek, 1966).

Defoliation of barley grass by humans was plant selective gathering. Pristine gatherers defoliate or gather only those plants or their parts which are of use to them (Mamatamayee, 1991b). Plant selective gathering is beginning of rudimentary form of cultivation. The texa selected for gathering must be protected against grazing, browsing, picking by birds, damage by winds or other agents. Some damaged plants may be re-or translocated by humans in their continued effort for protection. The early Kalibangans could have learnt to grow berries by inadvartedly scattering seeds or burying vegetatively growing stems in conformity with the theory of accidental origin of agriculture (Blake, 1970) but conscious effort for cultivation was necessary for survival of grasses. Prolonged protection causes domestication of plants whereby they loose their genetic and morphological ability to reproduce on their own in unprotected enviroment due to change from dehiscent to indehiscent seeds (Blumer and Byrne, 1991). Archaeological evidences from all over the world suggest that origin of

agriculture lies in food gathering (Rindos, 1984), the two being practised for long (Heiser, 1991) as in the pre Harppan cultures (Fairservis Jr., 1979) including Kalibangan. The very fact that the food and fodder crops survived their use by the Kalibangans suggest that the people were not only gathering but also cultivating them in their conscious or unconscious efforts.

Rindos' proposition holds true only in case of sickle-gathering (Blumer and Byrne, 1991),which prevailed in Europe with exception of France (Sauer, 1969). However the Kalibangans were using sickles of different kinds, including *parasu* which has no parallel in the Harappan culture (Lal, 1979 : 70). Sickles are the necessary artifacts of the gatherers who conserve their habitat in part removal of plants without constraining their continuous regeneration (Mamatamayee, 1991b). The pastoralists of Kalibangan used sickles to remove flower bearing stems of barley for food leaving the lower blades for foraging animals (Mamatamayee, 1992b) even when the grass seeds had not turned indehiscent completely. Barley in its cereal form yields coarse flour (WoI, 1959; Schery, 1972; Kochhar, 1981) which cannot be rolled to a *chapati* but nor could seeds of the dehiscent barley be used in this way. However, spikes of barley cereal, and the grass can be roasted and pounded using stone querns and mullers (Lal, 1979 : 67; Asthana, 1985 : 156) to make *sattu* or dough of the unroasted grains to bake directly on fire like the present day *bati* of Rajasthan. This form of cooking did not require ovens which are conspicuous by their absence till the middle level of occupation associated with Period-I in Kalibangan (Thapar, 1985).

Barley was only a small supplement to food from berries and animals in the practices of the Kalibangans before Period- II. Berry bearing plants have profusion of frutis and could be cultivated using neolithic hoes. Legumes grow sparsely in grassfields (Mamatamayee, 1992b) but intensification was necessary to feed the domesticated animals growing in numbers. The requirement was met in plough cultivation of fodder in Period-I. The artifact was in use further east as attested by excavation of a terracotta model of a plough from Banawali in Hissar district of Haryana (IAR, 1985-86). Barley continued to be sickle harvested from unploughed land. Defoliation of leaves twice or thrice before maturity of the grains made little impact on the yield as observed in Rajasthan (WoI, 1959). It survived sickle harvest by the early Kalibangans.

Prolonged defoliation of grasses and herbs for forage, fuel and food transformed them to cereals by Period-II. The transformation is attested by excavation of chaff, kernels, fragmentary spiklets of barley and, in few cases, of wheat (IAR, 1974-75). Since wheat is added only in small numbers and only in the upper levels of occupation, barley was the dominant vegetation with some intermingling of *Chana* and peas and dominated in the practices of the Kalibangans. Local origin gave sacred status to barley in the rituals of the people. Its origin was similar to rice in Daulatpur of Kurukshetra district in rice growing region of Haryana where lumps containing strains of wild and domesticated rice have been excavated (IAR, 1982-83) though late evolution of rice in early historic period denied the cereal a sacred status unlike barley. Sesamum also must have been a crop of local origin which gave a similar sacrificial status in the rituals of the Kalibangans who erected 'fire altars', the ritual structures unparalelled in the world. Barley must have been incorporated in plough farming when it transformed to a cereal by Period-II to keep pace with growing population of the urban Kalibangan.

Ecological Efficiency of the Kalibangan Habitat

The cereal cultivation evolved from gathering of berries, legumes and grasses which subsisted on natural soil water. Gathering eventually transformed to plant domestication

and cultivation, extending dry farming to cereal cultivation. The Kalibangan habitat was liable to support the crop on rain fed soil, excluding the necessity of irrigation. The river front and the levee hillocks could support the berries in use of the Kalibangans (Mamatamyee, 1991a). Cultuvation of these crops did not require neat plantations like the modern system. Instead, trees could be protected and cultivated in their individual stands without cognition of the rest of the vegetation (Mamatamayee, 1992c). Herbaceous plants tend to have a swarming habit so cucurbits made patches in the north while grasses clustered in the south (Mamatamayee, 1992b). Barley dominated the south as the necessary relation between plant morphology and genetics, and the liabilities of the Kalibangan habitat.

Barley has adventitious roots coming out from subterranean stems making it a tufted grass and supporting a mature, fruit laden spike (Kochhar, 1981) but constraining its growth in clay rich soils. Many shoots come out simultaneously from the adventitious root with a flush of water, making barley an annual. Occassional use of water enables barley to grow in somewhat aridic soils which the sand dominated soils are liable to be. This ecological relation enabled barley to diversify in Tibet and Abbesynia (Ethiopia), described by Vavilov as the centres of origin of barley. Anomolies in Vavilov's concept, as explained by (Harlan, 1971, 1976), Harris (1967), Hawks (1970), Isaac (1970), Helbaek (1959, 1966), and Flannery (1973) confirm more local and simultaneous origin of barley in widely separated or contiunous areas of the world, which includes Kalibangan.

Local origin of barley in Kalibangan was enabled by sandy habitat in the south. Sand was deposited by the Ghaggar in spate. Sand content of a channel load decreases with decreasing velocity and increasing distance from its bed (Penka et al., 1985) which would have made the south deficient in sand relative to the riverine north (Fig. 1). However, Kalibangan was sitting over rolling sand dunes (IAR, 1960-61; Lal and Thapar, 1967; Lal, 1984) as a result of increased climatic aridity at the beginning of the Holocene (Vishnu-Mittre, 1978; Vishnu Mittre et al., 1985). Wind blown sand was deposited over the levees forming obstacle dunes, and was found to cover depressions (Lal, 1979), the excavated field (Lal, 1971) and the settlement of Period I when it was temporarily abandoned just before the arrival of the Harappans (Lal, 1984).

Sand was natural to Kalibangan habitat and barley natural to sandy slopes of the south in keeping with the pioneering role of grasses on a newly emergent land. Sand pores in the north of the levee were too water logged to enable growth of adventitious roots of barley constraining its spread to the south (Mamatamayee, 1992b). Clay rich micro depressions of the south could support tropical forest common to a humid climate (Penka et al., 1985) but the association of climate and vegetation specific to northen Rajasthan since the beginning of the Holocene supported a savanna like woodland or a riverine thorn forest (Vishnu-Mittre 1979; Vishnu-Mittre and Saxena, 1980).

The south could have been too dry for barley and other crops being domesticated by the Kalibangans restraining them from dry farming but the evidence suggest the contrary :

1. The excavated ploughed field was located at the mouth of the gullies converging in the south of the central gap from the north, west and the east (Fig. 2). The gullies carried sufficient soil water to feed the crops for which the field was ploughed but which could also support barley as attested by frequent damage to the fortification walls erected on the gap. People of Period I erected walls along the levee flank in the north, west and south of the KLB-1 but the eastern wall ran over the mouths of the gullies on western flank of KLB-2. Damage to the eastern wall by soil water flow necessitsted the people of the Period II to relocate the wall over the mudbrick dwellings of Period I on KLB-1 (IAR, 1964-65; Lal, 1967 : 11 :

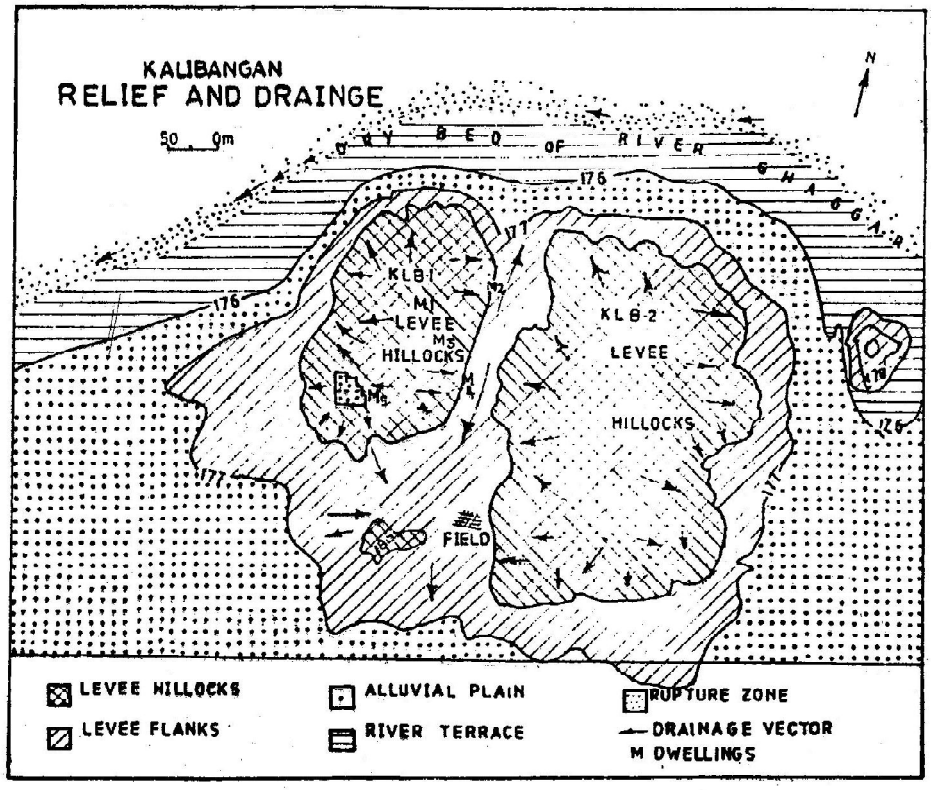
KALIBANGAN
RELIEF AND DRAINGE
50 0m
DRY BED OF RIVER GHAGGARA
N
176
177
KLB-1
LEVEE
HILLOCKS
KLB-2
LEVEE
HILLOCKS
FIELD
LEVEE HILLOCKS
LEVEE FLANKS
ALLUVIAL PLAIN
RIVER TERRACE
RUPTURE ZONE
DRAINAGE VECTOR
M DWELLINGS

Fig. 1

Thapar, 1975 : 25) joining the previously existing eastern wall to the plan of the western wall of KLB-2 (Fig. 2) but was completely eroded over time (IAR, 1964-65).

2. Soil water was not confined to the gap. Enough water moved to the south leaving no trace of the fortification wall in the south of KLB-2 (IAR, 1963-64) while only mud brick material of the southern wall could be traced on KLB-1(IAR, 1968-69).

3. The fortification walls were not damaged due to neglect and disuse. They were damaged during occupation of the Kalibangans necessitating their reinforcement thereby increasing their width from 1.10m to more than 4m in Period I and upto 11m in Period II (IAR, 1962-63; Lal, 1979; Thapar, 1979) on places most damaged by soil water flow, specially in south.

4. Most spectacular effect of soil water flow was evident in a rupture zone in the south-western corner of KLB-1 (Fig. 2) which developed at the end of Period -I. It is believed to be a seismic fault and the cause of the demise of Kalibangan of Period I (IAR, 1962-63; 1965-66; Raikes, 1968, 1984; Thapar, 1975, 1985; Lal, 1979, 1981; Lal and Thapar, 1967) though A. Ghosh doubts validity of the belief (EoIA, 1989 : 201-202). The theory of seismic fault cannot explain why only a corner of the levee was effected without damaging the other clusters of mud bricks on the KLB-1.

The subsided walls and the disjointed mud floors of some of the damaged houses in the south western corner of the levee were the result of mass wasting caused by soil water. Soil water dissolves minerals most susceptible to chemical weathering, such as calcium in duricrusts of late Pleistocene (Goudie, 1983). Matter located above the dissolved minerals subside affecting a shallow layer of surface material of all grades (Femran and Jeje, 1983; Douglas, 1977). Movement causes tilting of trees or other structures of shallow foundations. Mass wasting had slipped foundations of those houses of the western cluster which were located on the walls of large gully depression (M5 in Fig. 2) without affecting the other dwellings located in hill tops or the flanks of the levee (Fig. 1).

5. There was enough water on the hillocks to move down the flanks of the levee as suggested by use of terracota nodules and charcoal in foundations of some of the houses of Period II (IAR, 1960-61). This was to keep off moisture and termites which breed on it (Thapar, 1975, 1985; Lal, 1984; Asthana, 1985). Roasting of grains bearing spikes had taught the Kalibangans the use of fire in keeping away moisture. Lime plastered cylinderical pit of Period II had the same purpose but perhaps the technology was imported.

Exclusion of Irrigation System

The practice of dry farming in Kalibangan was not distinguished in cultivation of berries of legumes but of cereals. There is no sign of irrigation in Kalibangan though the crop is irrigated now (Gupta, 1978). The Kalibangans could have devised irrigation if they were unable to raise the crops otherwise. Instead, they excluded inundated land from selection of the cropland.

Exclusion of irrigation from farming is suggested by location of wells in courtyards of houses or near the place of rituals (IAR, 1962-63). Their linings were continously raised to meet the rising level of occupation (IAR, 1966-67). Excavation of a single drain ending a short distance away from the 'fire altars' suggests that it was laid to prevent slushing of the place (Thapar, 1975, 1979, 1985; Lal,,1984; Lal and Thapar, 1967), not to irrigate crops in use of the people.

A levee flank was a gathering field and the potential subject of irrigation as suggested by the gridiron street plan of the main residential area on the levee mount KLB-2. Main north-south running highways stopped 5m short of the inner phase of the fortification walls in the north (IAR, 1968- 69). The gap was an extension of the riverine woodland

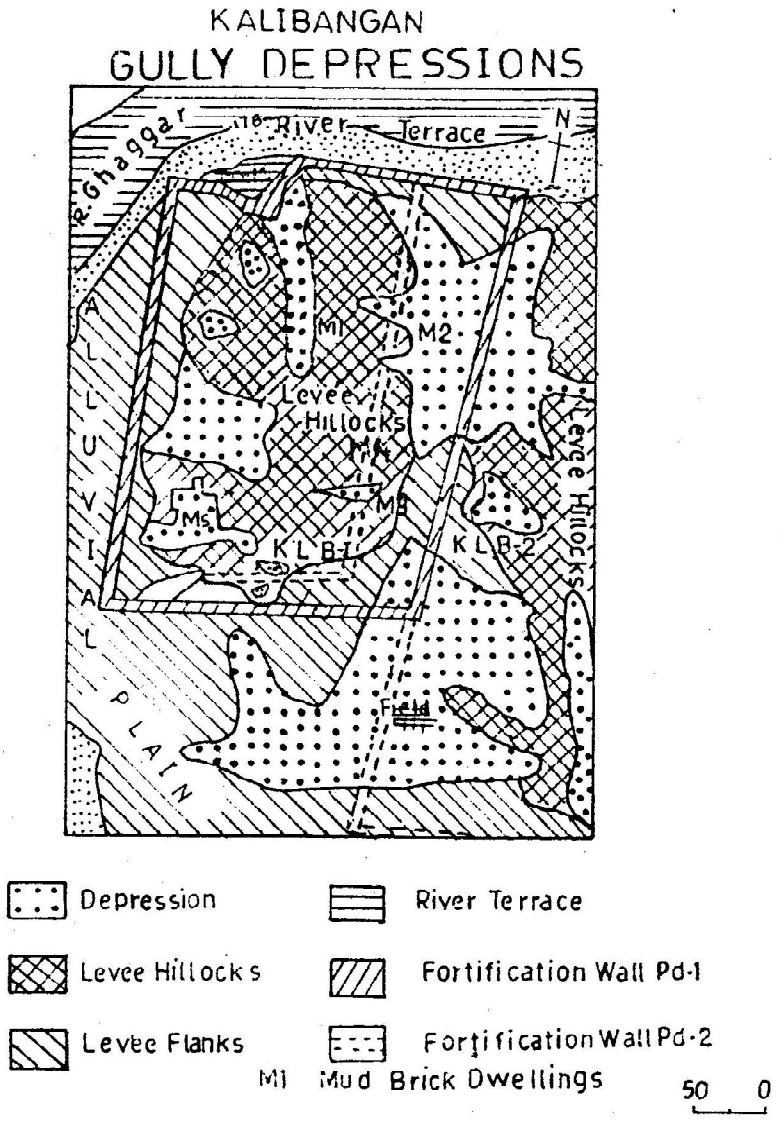
KALIBANGAN
GULLY DEPRESSIONS
R. Ghaggar
River Terrace
N
ALLUVIAL PLAIN
M1
M2
Levee Hillocks
M4
M3
Ms
KLB-1
KLB-2
Levee Hillocks
Field
Depression
River Terrace
Levee Hillocks
Fortification Wall Pd-1
Levee Flanks
Fortification Wall Pd-2
MI Mud Brick Dwellings
50 0

Fig. 2

(Mamtamayee, 1991a) surviving on water seeping from the river and the gullies moving north (Fig. 1). The woodland was also a vegetation gap which gave added defence to the fortification of the levee from the riverside. Grasses or herbs dominated other flanks of the levee and could not give added defence. Leaving a vegetation gap would have been redundant though their absence or presence cannot be confirmed due to erosion of the walls on these sides.

Small patches of unirrigated croplands were located on levee hillocks also as suggested by staggered plans of smaller alleys radiating from the highways. The alleys led to wattle huts similar to those of potters located in the south of the fortification wall of the 'Citadel' on KLB-1 during Period II. Residence of potters in the class divided society of the Kalibangans is suggested by extensive dispersal of sherds of pottery in the area (Lal, 1984; Jain, 1979; Thapar, 1985; Asthana, 1985). Perishable huts left no material evidence of their existence unlike mud-brick structures of other populations. Unirrigated vegetation sustained dwellers of the huts. Absence of drains enabled water from soakage jars of Period II to feed water to the crops of the hillocks.

The excavated field was located about 2m above the Ghaggar (Fig. 1). The river had to inundate the terrace in the north and the alluvial plain along entire length of 1.5km to 2km long perimeter of the levees to inundate the site of the excavated field. This required phenomenal rise in the river level but the Ghaggar had been lowering its bed since the beginning of civilization (Raikes, 1968, 1984; Lal, 1979). Flood could be a cause of the end of civilization at Mohenjodaro (Raikes, 1965) but absence of floods in Rajasthan is confirmed by evidences of palaeoclimate (Singh, 1971; Agrawal, 1980). There is no evidence that the fortification walls were raised against flood in the Ghaggar (Lal, 1979). Inundating water could not reach the excavated field.

The excavated ploughed field was found to be abandonded before period II. The field could have been abandoned to look for better watered alluvial plain in the south. How- ever, *Artemesia* dominated xeromorphic vegetation of the northern Rajasthan (Vishnu-Mittre, 1978, 1979; Vishnu-Mittre et al., 1985) suggest increasing soil aridity towards the south though micro depressions would have been water logged at the time of sowing of the *rabi*, which was the main cropping season of Kalibangan (Thapar, 1979; Lal and Thapar, 1967), and which included barley. Water and silt laden depressions were left uncultivated, constraining the Kalibangans to continue with dry farming even after the metropolis expanded over the ploughed field during Period II.

CONCLUSION

The Kalibangans practised dry farming of cereals not due to unavailability of water for irrigation but in their conscious effort as extension to the practices of gathering. Gathering transformed to domestication of plants and then to plough farming. Inundated land was left uncultivated. This suggests that the Kalibangans could grow their food even after the Ghaggar had turned dry. Demise of Kalibangan must be sought in some other proposition as suggested by Gupta (1978).

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