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Land Utilization in a South Deccan Village: Contrasts between Tank-irrigated and Rain-fed Cultivation

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I Introduction

Karnataka State, in the western section of the southern-most zone of the Indian Subcontinent, is divided into three geographical units:

1. A narrow coastal plain facing the Arabian Sea.
2. The Western Ghats mountain area, called *Malnad* (hill area) in the official state language, Kannada.
3. The Karnataka Plateau, a southern extension of the Deccan Plateau. The plateau is locally called *Maidan*, which means vast open land. *Maidan* is further divided into northern and southern parts, which exhibit sharp contrasts in agricultural landscape [Singh 1971: 819 ff].

Northern *Maidan* is characterized by relatively low elevation (300 to 600 m. msl.), a more arid climate (520 mm/year at Bellary), black cotton soil, cultivation of *jowar* (sorghum, *Sorghum bicolor*), cotton and groundnuts under rain-fed conditions, flat-rooved (mainly mud) farm-houses, and a predominance of large agglomerated villages.

On the other hand, southern *Maidan* is characterized by relatively high elevation (600 to 900 m. msl.), a more humid climate (924 mm/year at Bangalore), red soil, cultivation of *ragi* (finger millet, *Eleusine coracana*) in the rain-fed area and of paddy and sugarcane in the tank-irrigated area, ridge-rooved (mainly thatched or tiled) farm-houses, and a predominance of small agglomerated villages and/or hamlets.

The village we studied, Aralamallige,[1] is located in southern *Maidan* and is similar to other villages in the area except for its size. The population of Aralamallige was 1,436 (1971 census), while rural population per village in Bangalore District, to which the village belongs, was 550 in the same year. However, especially in terms of ecological setting and agricultural land utilization, Aralamallige is a fair representative of *Maidan* villages.

II Geographical Description of the Surrounding Area

Aralamallige is located about 40 km north of Bangalore City, the State capital of Karnataka, and some 5 km southwest of

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1) For the general description of Aralamallige, see Fujiwara [1980: Chapter 7] and Census of India [1967].

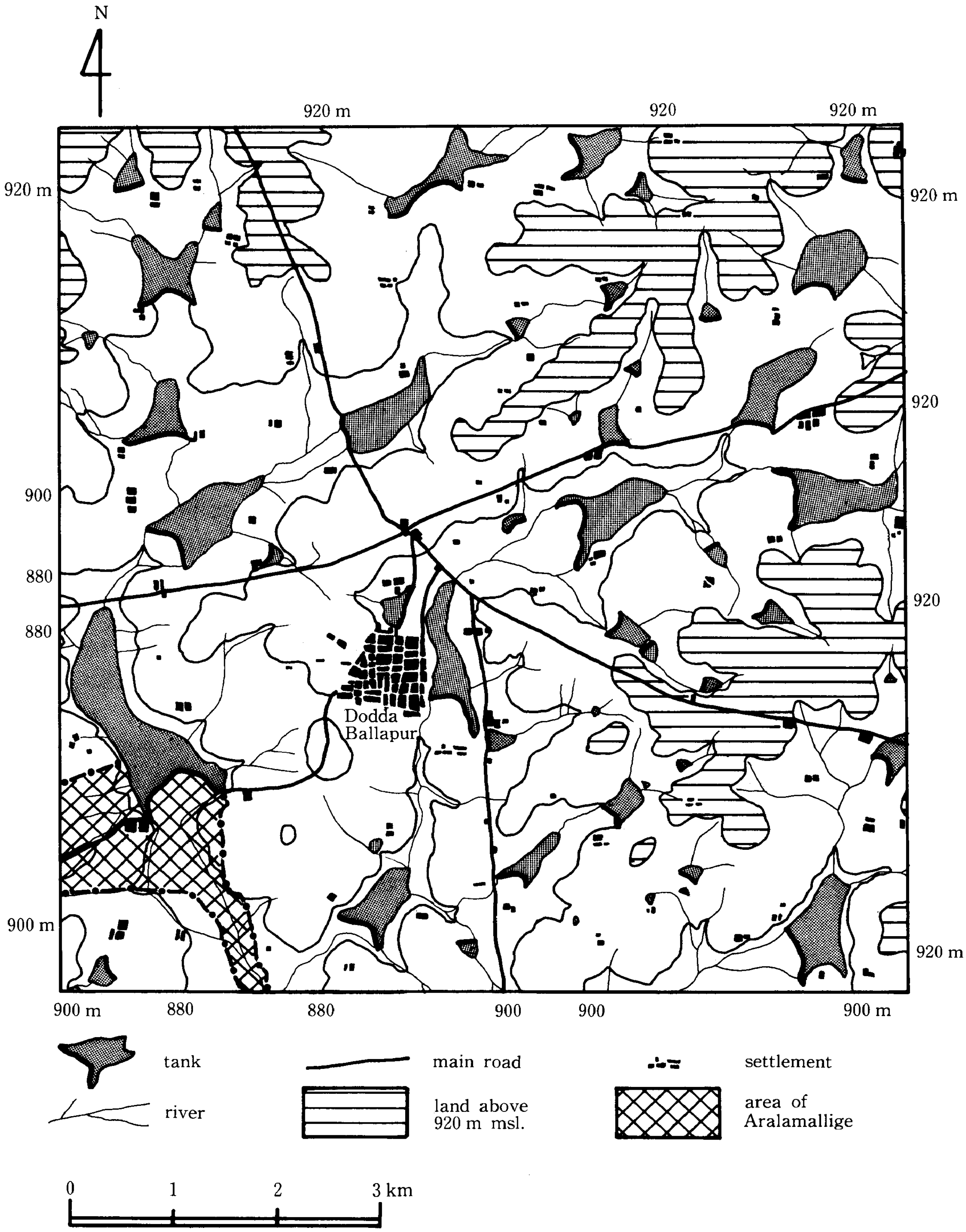

Fig. 1 Area Surrounding Aralamallige

Doddaballapur Town, the *Taluk* (County) seat. Fig. 1 shows the topographical situation of the area; Aralamallige is shown in the southwest corner of the figure. Three kinds of landform are found:

1. Upland: a gently undulating plateau of granitic origin, which is dissected by small streams. In some parts, there are inselbergs and boulders. Except for patches irrigated by small tanks constructed at the head of stream, this area features mainly rain-fed cultivation and grazing. Recently, however, two significant changes in land use have occurred; first, some rich farmers have developed small gardens irrigated by tube-wells and, second, the extension of casuarina and eucalyptus planting, i.e., change from rain-fed agriculture to forestry owing to rainfall instability.
2. Gentle slopes: narrow belts between upland and valley bottoms on which rain-fed agriculture predominates. Tube-wells are more common here than in the uplands. However, in the area dissected by streams, because of unfavourable conditions created by gullies and soil erosion, uncultivable land is abundant.
3. River valleys: wide but shallow valley plains. This area is part of the drainage system of the Akravathi River, a tributary of the Cauvery River. Each river valley is easily traced by following the chains of tanks in Fig. 1. The tanks have roughly U-shaped banks, 5 to 7 m high for medium and large tanks, on the downstream side. Tank water is recycled and used intensively. Fig. 1 shows how the rivers and watercourses from each tank first irrigate their management area, and then discharge residual and over-flow water into the next tank downstream, which is also fed by several other small streams from adjacent upland areas. The same water utilization cycle is repeated again and again and is so exhaustive and intricate that fluctuations in rainfall have direct effects on tank-irrigated agriculture. In spite of the vast areas given over to tanks —— Fig. 1 shows tanks occupy almost as much land as is cultivated in valley plains —— agriculture is more unstable here than on the upland.

Land use in river valley is divided into the following three zones with increasing distance from tanks, i.e., decreasing water availability. The first zone, adjacent to the tank, is used for gardens. For large and/or perennial tanks, land utilization is characterized by a "betel nut palm — coconut palm — banana — irrigated *ragi* — sugarcane — paddy" complex. The first three are typical 'wet' crops cultivated in tank-irrigated gardens. In the next zone, cultivation of sugarcane and paddy becomes dominant. In the next, paddy predominates. The last two zones can be called tank-irrigated land.

River valleys enjoy a high water table which has led to the construction of tube-wells in recent years. This has meant that gardens and irrigated land have become similar and thus increased

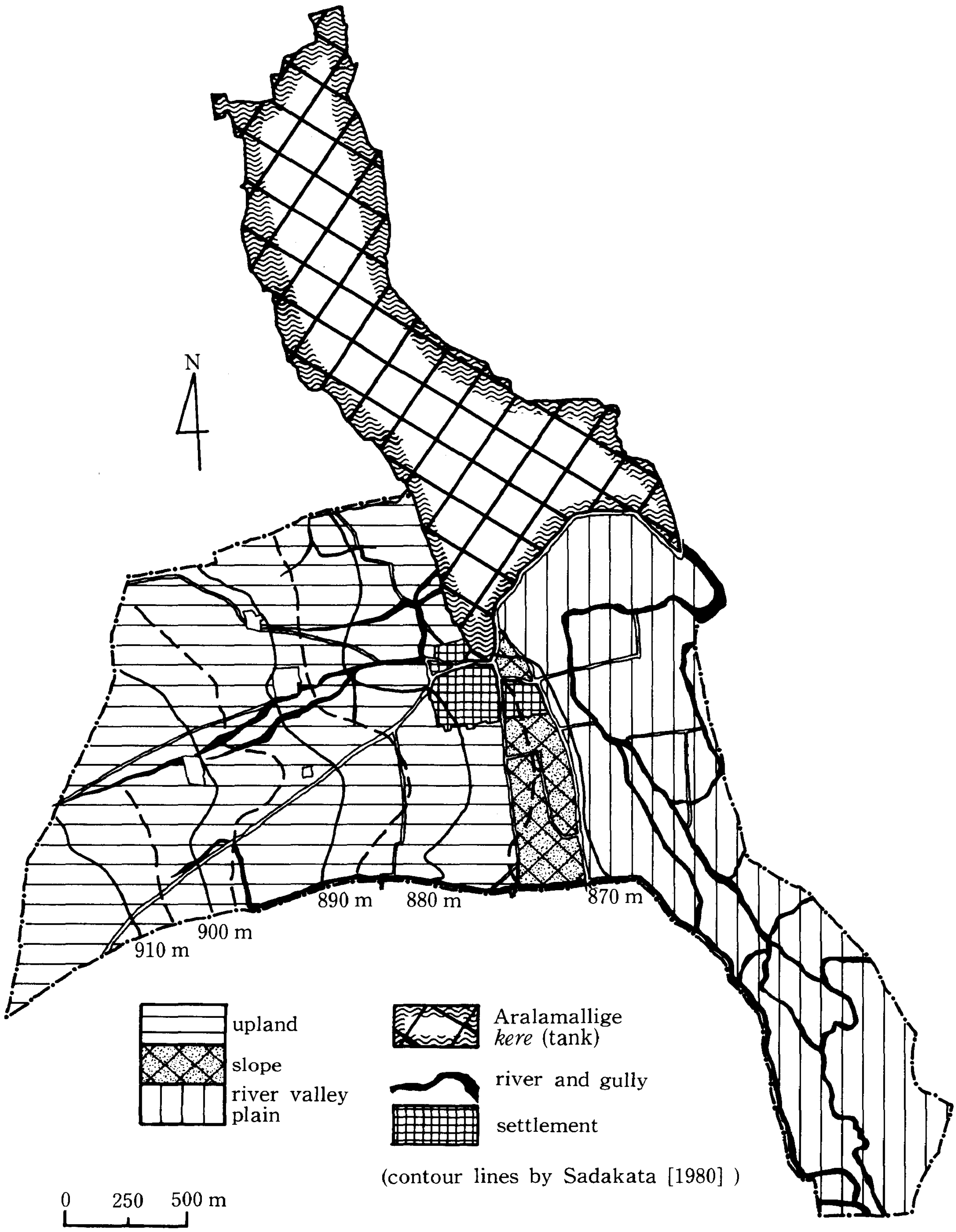

Fig. 2 Geomorphological Map of Aralamallige

agricultural stability. Tanks have the two functions of providing both surface and underground water for irrigation. Under the drought conditions prevailing in recent years, the latter has acquired more significance.

Fig. 2 is a geomorphological map of Aralamallige. The narrow 'slope' belt, between the upland to the west and the river valley plain to the east, is flanked by two roads running from the eastern part of the village settlement.

Table 1 shows the classification of the village land according to the *Pahani* (land record book). Cultivated land makes up 58.1% of the total. Compared with other neighbouring villages, this percentage is rather small, because of the big tank called Aralamallige *kere*. This tank is one of the biggest in this area, occupying as much as 185 ha. It irrigates the Aralamallige village land and that of six other villages downstream.

Table 1 Classification of Village Land, Aralamallige

	area (ha.)	%
cultivated land	433.7	58.1
(irrigated)	(165.1)	(27.8)
(rain-fed)	(268.6)	(30.3)
grazing land	82.5	11.1
cultivable waste	11.6	1.6
uncultivable land*	212.0	28.4
settlement site	5.7	0.8
total	745.5	100.0

* tank: 185.1, road: 13.5, watercourse: 6.0 (according to the *Pahani* —— land record book)

The villagers say that the tank was constructed about 200 years ago and has been gradually silting up ever since, to such an extent that its capacity today is said to be only one fifth of its original capacity. Combined with the scarcity of rainfall in recent years, this has made irrigated agriculture in the village more unstable. The tank has four *tubu*, from "tube", and meaning sluice gate, in addition to an outlet in the southeastern corner (Fig. 2). Each sluice gate has a main watercourse called *rajagalube* which are further divided into several small watercourses called *tollugalube*. The sluice gate adjacent to the mouth of the outlet might be used for irrigation in years when the tank fills to capacity, which has occurred only once in the last 10 years. The most significant *tubu* is in the southwestern corner where the tank is the deepest. However, for the last four years, even this *tubu* could not supply water to the fields. In July 1982, the tank was completely dry except for some small patches which were dug and used for grazing.

Most cultivated land is of two types, *kanne*, on the river plains, and *dinne*, on the upland and slopes. The boundary between them is a path running from the eastern edge of the settlement to the south (Fig. 2).

Kanne is tank-irrigated land and is also referred to as *nilawari zamin* (land of watering). It stretches along the river valleys to the far south of the tank. This area is low and flat; the surface soil is dark brown and mainly loam and clay [Sadakata 1980: 104–117]. The best *kanne* land is found between the *rajagalube* and the river, beside the boundary path mentioned above. Betel nut palms, the typical tank-irrigated *thota* (garden) crop, are concentrated in the upper portion of the area. Even here, fallow and barren lands have increased due to drought conditions in recent years, as shown in Fig. 6 later.

A positive response to drought conditions is the construction of wells. Those on *kanne* land are divided into two types. The first are open wells or small ponds without pumping equipment, constructed in the past, and restricted to the area near the bank of the tank where groundwater is higher (Fig. 3). Water is drawn with buckets or a sweep. The other type are tube-wells with electric pumps constructed in recent years. They are distributed along the river and in the western zone of the river plain, adjacent to the slopes.

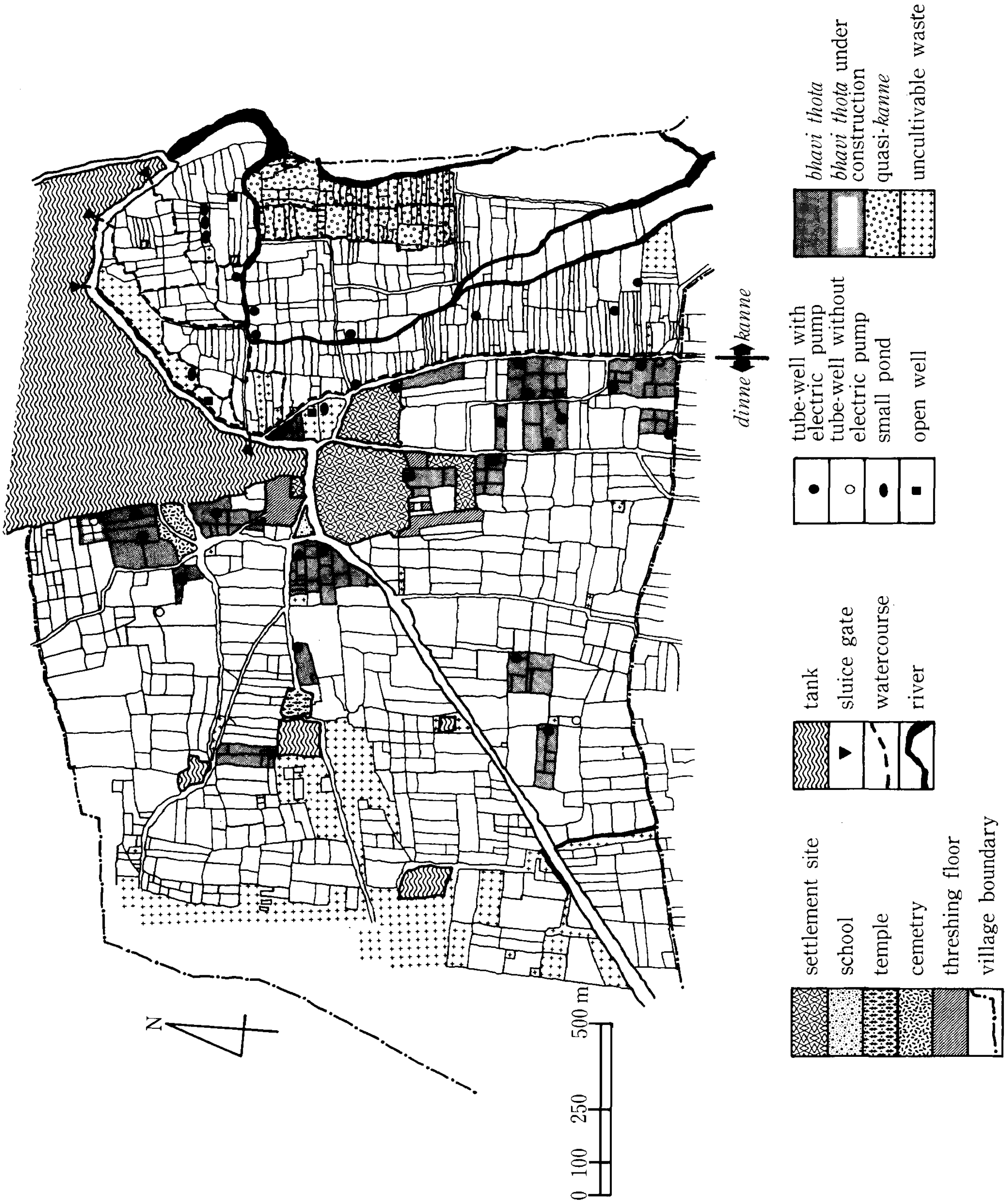

Fig. 3 Land Classification Map, Aralamallige

Here *kanne* land receives supplementary irrigation from tube-wells. However, in recent years, irrigation has solely depended on wells.

The central eastern section of *kanne* land is irrigated by two watercourses from the river (Fig. 3). Only when the river is full, which occurs very rarely, can the land in this section receive water. Although it is classified as irrigated land, in practice it is a rainfed area and shows similar land utilization to *dinne* land (Fig. 6).

Dinne or *kushki zamin* (dry land) is found on the upland and slopes. The upland attains its highest elevation, about 910 m, on the southwestern periphery of the village area (Fig. 2). The higher western upland area is covered by laterite duricrust and is an uncultivable waste. In the V-shaped area extending from the higher area in the northwest to the north edge of the settlement, shallow valleys and gullies have developed. Owing to its active soil and gully erosion, this area is also uncultivable (Fig. 3). With these exceptions the upland area is used for rain-fed agriculture and tree plantations. The *dinne* area is mainly covered with red soil except for an area of laterite soil in the west and a mixed black and red soil in the southwestern corner of the village lands.

Wells for irrigation have been constructed in the *dinne* area since the 1950s. Until 1970 they were limited to the area near the tank and the slope area, where groundwater is relatively abundant, but since then they have also been dug in the inner portion of the upland, where the groundwater level is lower and its fluctuation between wet and dry seasons is more pronounced. Fig. 4 shows a typical

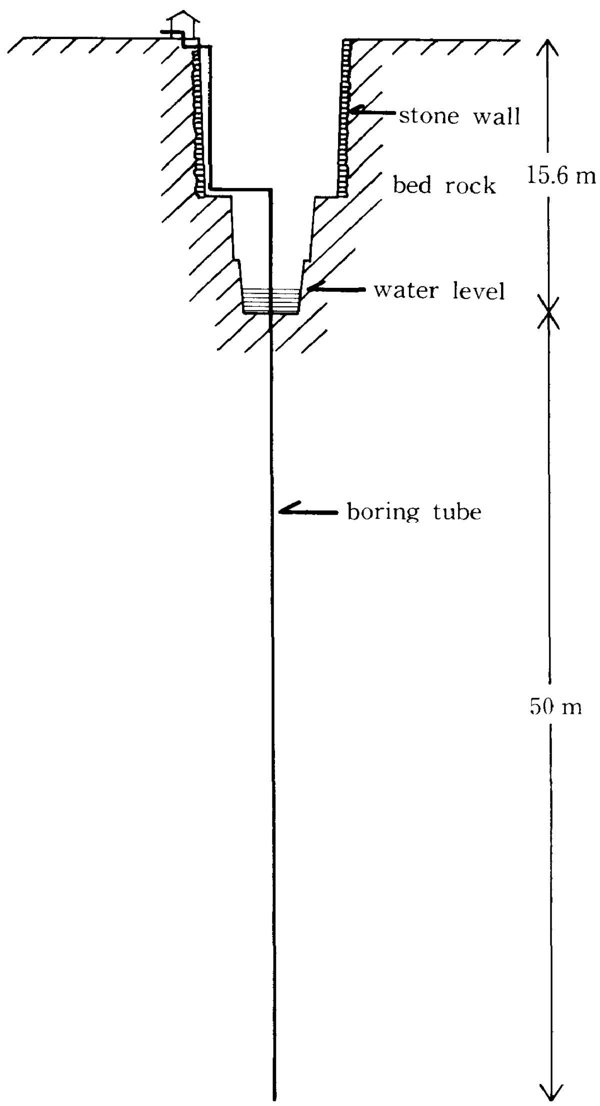

Fig. 4 Section of a Typical Upland Tube-well, Aralamallige

upland *dinne* well. The upper portion is a three-storied open well whose cylindrical wall is covered with granite blocks. It has an internal diameter of 8 m at the surface and a depth of 16 m to the bottom of the stone wall at groundwater level. The lower portion consists of an iron pipe bored through the bedrock to a depth of 50 m below the bottom of the open well. Thus, in total, the well is 61 m deep. The main reason for constructing such large, deep wells, is that available water is stored only in cracks in the weathered bedrock at fair depth. Land irrigated by tube-wells in upland and slope areas is called *bhavi thota* (garden irrigated by well). *Bhavi thota* are small, most plots being 0.8 to 1.2 ha., depending on the reliability of the water supply (Fig. 3). In contrast to open *dinne* land, *bhavi thota* are enclosed with wire entanglements.

In conclusion, we can divide the village's cultivated land into five categories, roughly arranged from west to east:

(1) *Dinne* proper, rain-fed.

(2) *Bhavi thota*, converted from *dinne* land by the introduction of tube-wells.

(3) *Kanne*-cum-*thota*, irrigated by both tank and tube-wells.

(4) *Kanne* proper, irrigated by tank.

(5) Quasi-*kanne*, *kanne* but, in effect, *dinne*, on the central eastern edge of the village.

This broad classification is made on the basis of the main sources of water for cultivation and irrigation. The extent of each type can be ascertained from Fig. 3, except for type (3), *kanne*-cum-*thota* land, which is found on the northern and western river plains. Here it is difficult to ascertain the limits of *kanne*-cum-*thota* land and, therefore, type (3) is combined with type (4) in further analysis.

I conducted a field-to-field land utilization survey on 267.6 ha. of cultivated land around the village settlement. The total acreage of each type of land found was: 1. *dinne*: 170.2 ha. (63.6%); 2. *bhavi thota*: 19.4 ha. (7.3%), 24 tube-wells; 3. & 4. *kanne*: 67.8 ha. (25.3%); and 5. quasi-*kanne*: 10.2 ha. (3.8%). *Dinne* and *kanne* not only occupy the largest area, but also feature individual peculiarities in terms of agricultural landscape and land utilization. We shall devote our discussion to the sharp contrasts observed between them.

III Contrasts between *Kanne* and *Dinne*

1) Shape of Land-use Units

Land-use unit means a plot of land on which we can observe homogeneity in both crops cultivated and agricultural techniques. It is the minimum unit for mapping land utilization. Sometimes it is the same as a parcel of land, but sometimes it is bigger or smaller. Fig. 3 shows sharp contrasts in the shape of land-use units in *kanne* and *dinne*. In particular, in the western part of the *kanne* area, the dominant shape is long (east-to-west) and narrow (north-to-south), which reflects the water distribution system.

Fig. 5 shows the schematic water distribution system of the western-most *rajagalube*, which irrigates *kanne* land in this area. Water from the tank flows to the head of the *rajagalube* through a siphon under the bank of the tank. At the mouth of the siphon one *tollugalube*, which irrigates 10 ha., branches off from the *rajagalube*. Another type of diverging watercourse is called *paipu*, after a small iron pipe buried under the footpath on the east side of the *rajagalube*. If there is sufficient water, all the pipes are allowed to supply water round the clock, but in the years of scarcity, watering hours have been limited to the day-time, and at night water should be allocated to the other villages downstream. In fact, only pipe No. 9 can supply water round the clock, for it is the last pipe in the village area, located near the village boundary. The irrigation capacities

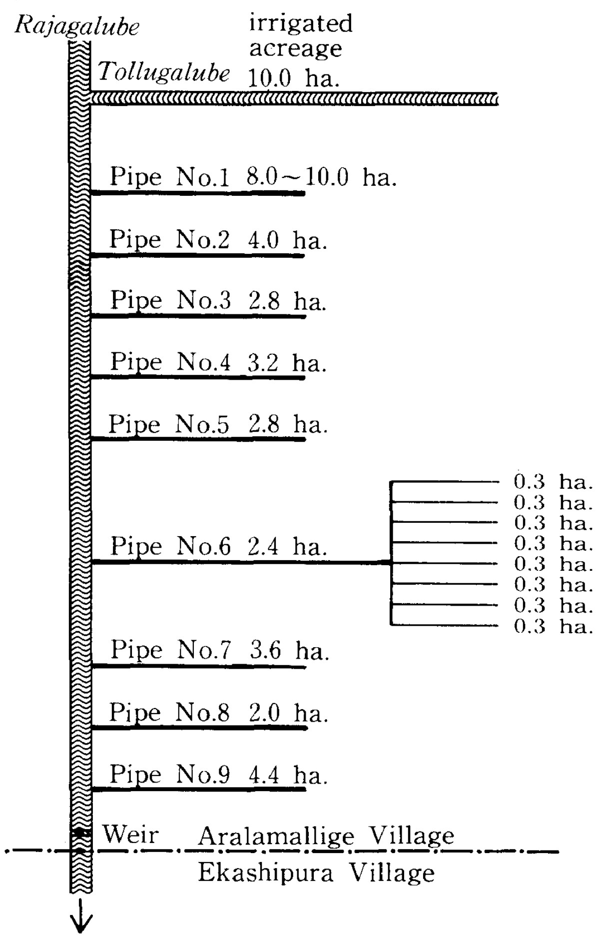

Fig. 5 Schematic Water Distribution System of the Western-most *Rajagalube*, Aralamallige

of the pipes vary. No. 1 is the biggest and irrigates 8 to 10 ha. of *thota*, planted mainly with betel nut palms. The other eight pipes irrigate 2 to 4.4 ha. of *kanne*, mainly planted with rice and sugarcane. If we take, for example, pipe No. 6, it is further divided into eight, smaller water channels, each of which irrigates an average of 0.3 ha. This size of plot is the minimum unit for irrigation, and has the long, narrow shape mentioned above.

Land-use units in *dinne* differ from those in *kanne* in two ways. One is that the dominant plot shape is a square or broad oblong, and the other is their larger size. In rainfed conditions, larger, square plots are more convenient for cultivation because important agricultural operations using bullocks, such as ploughing, harrowing, and thinning after germination, use cross-tilling methods.

2) *Main Crops*

Table 2 shows land utilization in the *kanne* and *dinne* surveyed, together with *bhavi thota* and quasi-*kanne*. Each type of land has different dominant crops. In *kanne*, they are rice, sugarcane and betel nut palm. In *dinne, ragi* and trees such as casuarina and eucalyptus. *Bhavi thota* show the greatest variety of crops, which depend on assured irrigation. Sugarcane, mulberry trees, vegetables, fruit and transplanted *ragi* are common. In quasi-*kanne*, casuarina and upland rice are dominant, showing the intermediate character, between *kanne* and *dinne*, of this type of land.

Mulberry trees were planted for the first time in 1979 and their introduction represents a major change in recent years. The area planted with mulberry trees is gradually increasing, but is overwhelmingly confined to *bhavi thota*. To compensate, the area under sugarcane has declined, since silk cocoons produce a higher return than jaggery. The other which are becoming more popular crops are casuarina and eucalyptus trees. These are grown in *dinne* in response to the drought in recent years. Both are cut after eight to 10 years, casuarina being sold mainly to Bangalore City as fuel for domestic use and eucalyptus to factories as a raw material for paper or textiles. To compensate for their expansion, the area under rain-fed *ragi* is decreasing. Affluent farmers confine production of *ragi* to

Table 2 Land Utilization by Land Type, Aralamallige (Surveyed in August and September, 1982)

land type / crop	*kanne*③ acreage	*kanne*③ %	*dinne*④ acreage	*dinne*④ %	*bhavi thota*⑤ acreage	*bhavi thota*⑤ %	quasi-*kanne* acreage	quasi-*kanne* %	total acreage	total %
cereals and millets										
*ragi*①	2.4 ha.	3.5	55.4 ha.	32.5	2.9 ha.	15.0	1.4 ha.	13.7	62.1 ha.	23.2
	(0.03)								(0.03)	
rice	15.8	23.3	8.6	5.1	0.2	1.0	1.9	18.6	26.5	9.9
	(4.0)						(0.5)		(4.5)	
maize			6.5	3.8					6.5	2.4
green fodder crops										
sorghum	0.4	0.6	1.8	1.1	0.7	3.6	0.2	2.0	3.1	1.2
oilseed crops										
castor			0.3	0.2					0.3	0.1
groundnut			—	—					—	—
vegetables and flowers										
tomato	1.0	1.5	0.9	0.5	1.0	5.2	0.1	1.0	3.0	1.1
eggplant	0.4	0.6			0.6	3.1			1.0	0.4
okra	0.1	0.2			0.2	1.0			0.3	0.1
purslane					0.2	1.0			0.2	0.1
chilli			0.1	0.1	0.1	0.5			0.2	0.1
flowers	0.5	0.7			0.2	1.0			0.7	0.3
fruit crops										
grape vine					0.7	3.6			0.7	0.3
guara					0.6	3.1			0.6	0.2
papaya					0.1	0.5			0.1	—
industrial crops										
sugarcane	19.2	28.3			7.4	38.1			26.6	9.9
	(0.5)								(0.5)	
mulberry	0.4	0.6			2.1	10.8			2.5	0.9
plantation crops										
betel nut palm	4.8	7.1			0.5	2.6			5.3	2.0
coconut palm	0.1	0.2			0.6	3.1			0.7	0.3
planted woodland										
casuarina	2.5	3.7	74.7	43.8	0.5	2.6	5.0	49.1	82.7	30.9
eucalyptus	0.2	0.3	21.4	12.6			0.3	2.9	21.9	8.2
nursery beds										
ragi					0.3	1.6			0.3	0.1
being ploughed	6.5	9.6			0.5	2.6	1.0	9.8	7.3	2.7
fallow②	13.5	19.8	0.5	0.3			0.3	2.9	15.0	5.6
total	67.8	100.0	170.2	100.0	19.4	100.0	10.2	100.0	267.6	100.0

( ): premature decay　—: less than 0.1 ha.
①: finger millet　②: including cultivable waste　③: tank-irrigated land
④: rain-fed land　⑤: land irrigated by tube-well

the amount necessary for family consumption and convert the excess land to woodland.

3) Spatial Organization of Land Use

Fig. 6 is a map of land utilization in the village in August and September, 1982. It shows that the spatial organization of land use has developed on basically different principles in *kanne* and *dinne*. The western half of the *kanne* has more reliable irrigation facilities

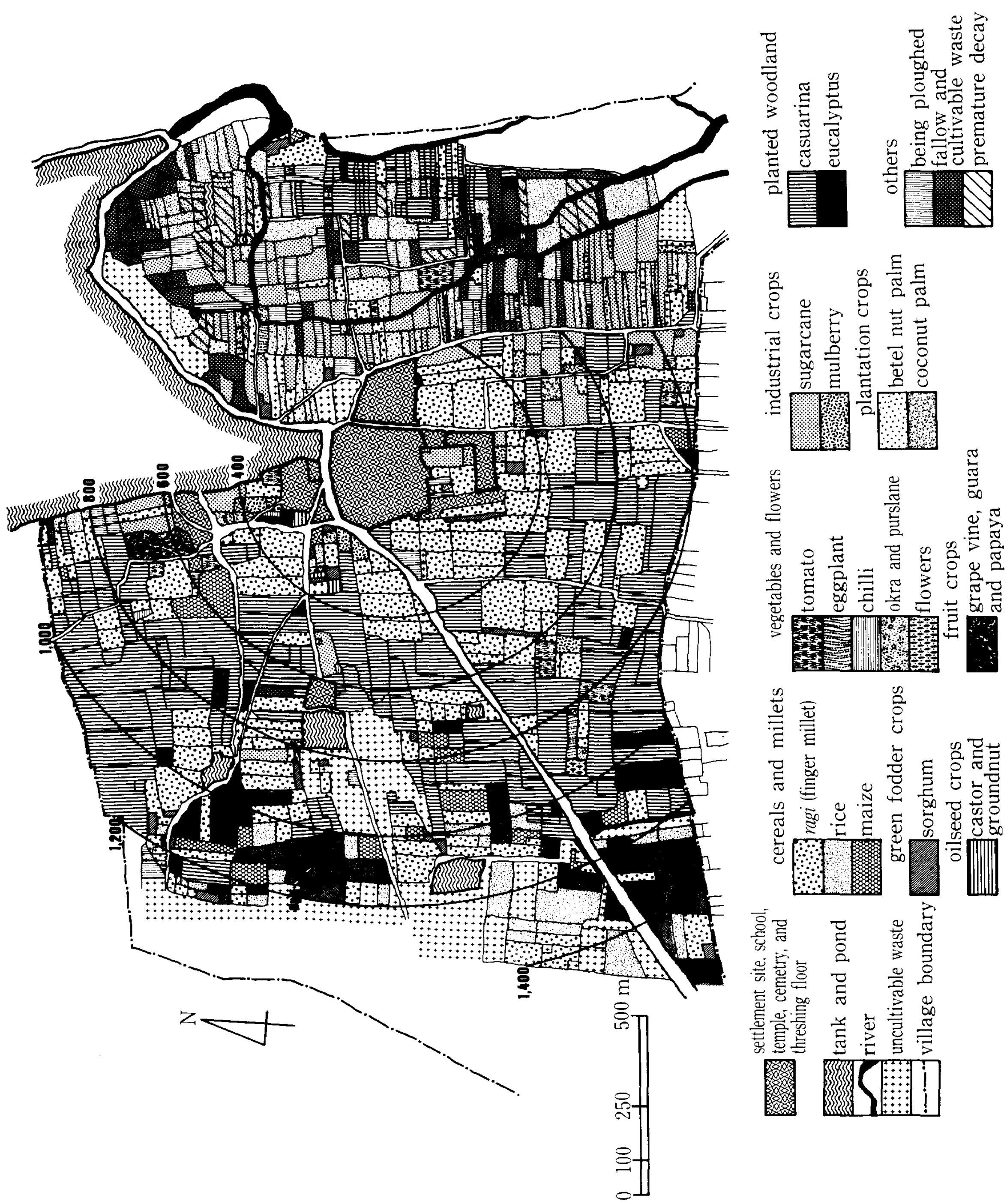

Fig. 6 Land Utilization Map, Aralamallige (Surveyed in August and September, 1982)

owing to the concentration of tube-well construction there. Sugarcane is the most important crop with a concentration of betel nut palms in the upper part, i.e., the former *thota* area irrigated by water from the tank. In contrast, in the eastern half, where irrigation fully depends on tank water, paddy is the most prevalent crop. Due to the unreliable irrigation facilities, paddy fields in a state of premature decay are concentrated in this area.

Thus, we can conclude that the key factor

Table 3 Crop Composition in Concentric Rings in *Dinne* Proper, Aralamallige

concentric rings / crop	I 0～ 400 m	II 400～ 600 m	III 600～ 800 m	IV 800～ 1,000 m	V 1,000～ 1,200 m	VI 1,200～ m	total
ragi	81.6%	38.5%	28.2%	23.5%	21.3%	20.0%	32.5%
rice				2.0	8.5	30.3	5.1
maize		4.5	2.8	3.6	8.9	0.6	3.8
sorghum	1.7	1.0	0.3	0.6	1.6	2.3	1.1
castor	1.7						0.2
tomato	1.1		0.8	1.1			0.5
chilli			0.3				0.1
casuarina	10.0	55.7	63.5	62.2	28.9	3.4	43.8
eucalyptus	3.9	0.3	2.8	7.0	30.8	43.4	12.6
fallow			1.3				0.3
total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

in spatial land-use patterns in *kanne* is the reliability of the irrigation facilities.

In contrast, in *dinne*, we observe concentric zoning of land use radiating outwards from the center of the settlement site. Ignoring small islands of *bhavi thota,* we can divide *dinne* proper into six rings (Fig. 6). The first ring is within 400 m of the center point in the settlement. The second through fifth rings are each 200 m wide and thus cover a circular belt 400 to 1,200 m from the center point. The sixth ring occupies the outer zone. Table 3 shows crop composition in each of the rings by percentage. The total acreage of planted *dinne* surveyed is 170.2 ha. Crops occupying more than 10% of this are

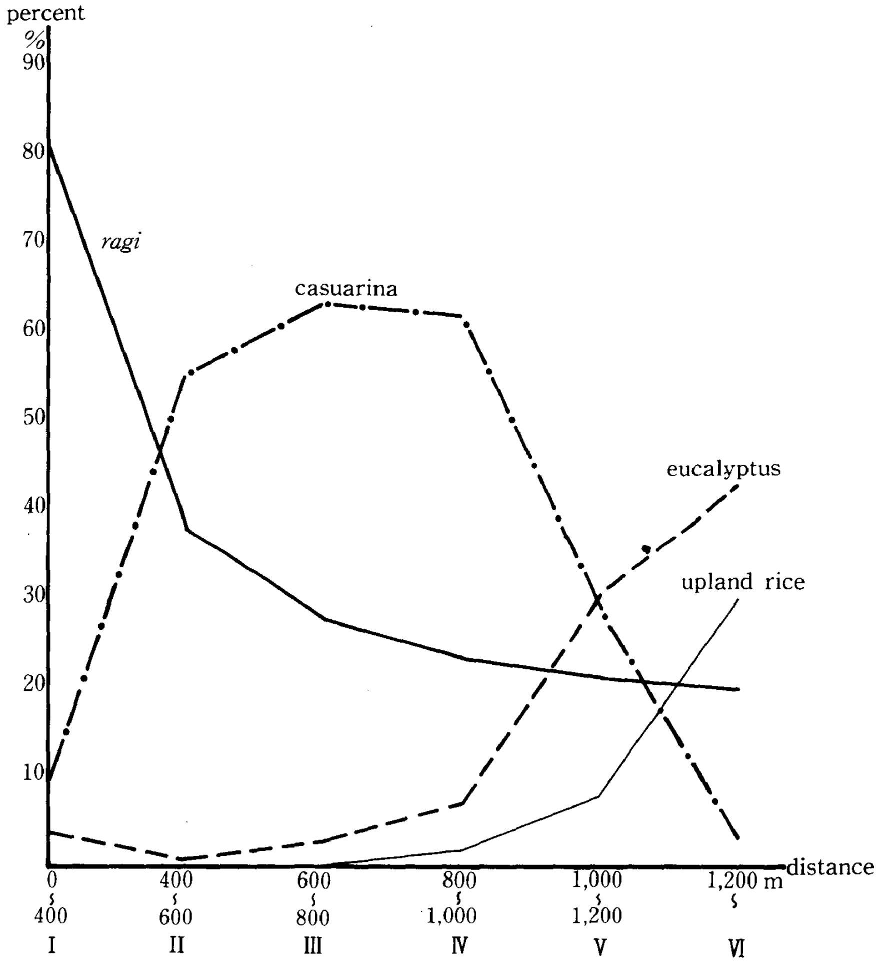

Fig. 7 Principal Crops in Concentric Rings in *Dinne* Proper, Aralamallige

casuarina (43.8%), *ragi* (32.5%), and eucalyptus (12.6%). Casuarina and eucalyptus thus occupy 56.4% whilst cereal crops, *ragi*, maize, and upland rice, occupy only 41.4%. We see here an expansion of artificial woodland in the *dinne* area.

Fig. 7 is prepared from Table 3, which shows the share of each principal crop in each ring. In the first ring, *ragi* predominates (81.6%), but, in the second ring declines sharply to 38.5%. It further decreases as we move outwards. Casuarina is relatively unimportant in the first ring, but occupies more than half in the second, third, and fourth rings. Eucalyptus is unimportant in the first four rings but is the most important crop in the fifth and sixth. Upland rice, which occupies only 5.1% of the total planted *dinne* area, has the second highest share in the two outermost rings.

We can thus further classify *dinne* into three concentric zones:

1. An inner zone, within some 400 m of the center: Rain-fed cultivation of *ragi* dominates.
2. An intermediate zone, approximately 400 to 1,000 m from the center: Casuarina woodland predominates. The classification of woodland by age of casuarina trees reveals a general trend for the ages of the trees to increase with distance from the center (Fig. 8). This means the area under casuarina plantation has expanded centripetally, from the periphery towards the inner zone.
3. A peripheral zone, more than 1,000 m from the center: Planted eucalyptus dominates. Rain-fed rice also claims a fair share because the mixed red and black soils which are suitable for rice

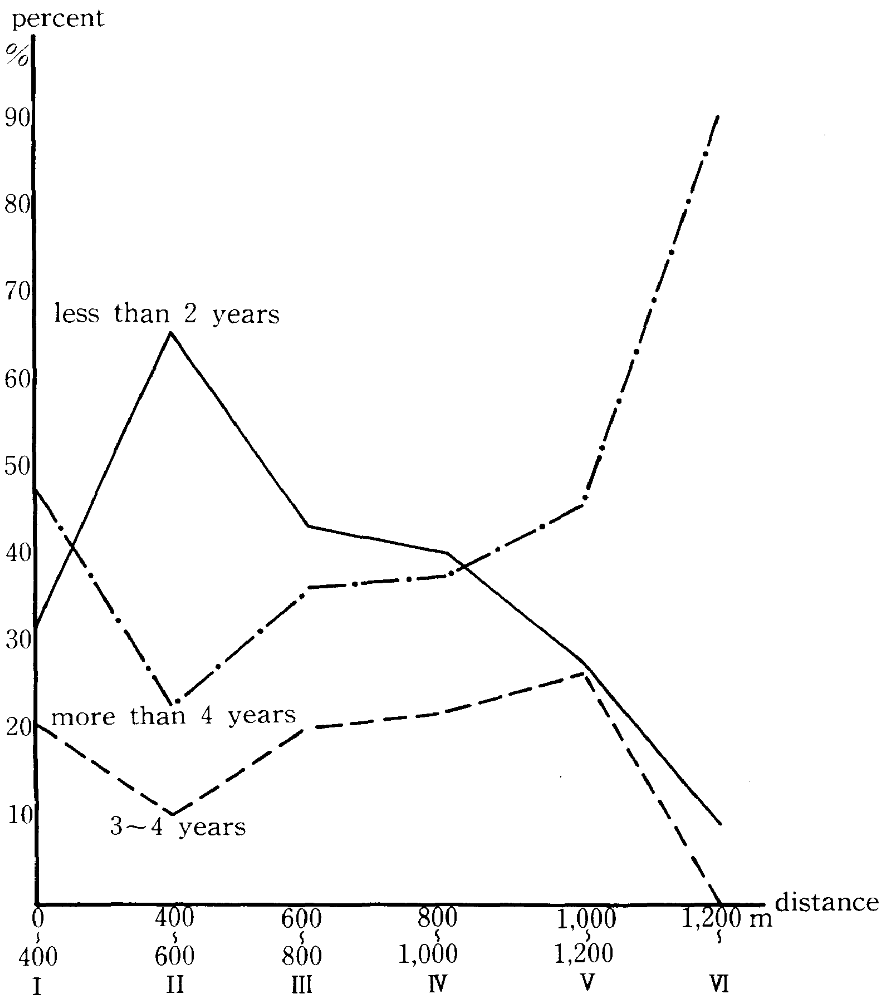

Fig. 8 Correlation between Age of Casuarina Woodland and Distance from Settlement Site in *Dinne* Proper, Aralamallige

cultivation are found in this area.

When asked why eucalyptus is planted in more remote areas than casuarina, farmers gave three major reasons:

1. Use for fuel: The leaves and twigs of casuarina are the main fuel for domestic use. Farmers frequently collect leaves and twigs in their own casuarina plantations and, for ease of transportation, it is more convenient to locate casuarina trees near their homes. On the contrary, the leaves and twigs of eucalyptus are not good for fuel, because the twigs are thinner than those of casuarina.
2. Development of root system: Eucalyptus develops a larger root system than casuarina. Its roots reach more than 1 m below the surface whilst those of casuarina reach only 30 cm in the same period. Thus it is easier to reconvert casuarina plantation back to cultivated land. Once eucalyptus is planted, however, the land will become permanent woodland. The farmers prefer to plant casuarina on land nearer their houses in order to provide for the future, when they will need to expand *ragi* cultivation.
3. Changes in soil quality: Whereas casuarina enriches soils, eucalyptus, as oil soaks through the roots, acidifies them. Farmers do not welcome deterioration of soil fertility in land closer to their homes.

Against reliability of irrigation facilities in *kanne*, we can conclude that in *dinne*, the key factor determining spatial organization of land use is distance from the settlement site. In *dinne*, a hidden distance-decay function is working in the spatial patterns of land utilization.[2)]

4) *Stability of Land Utilization*

Stability of cultivation is measured by two indices. One is the ratio of fallow land to the total acreage of each type of land. In calculating this ratio, fallow land and cultivable waste are combined because they are difficult to differentiate, particularly for land under fallow for more than one year. The other is the ratio of failed acreage or prematurely decayed land to the total area sown or planted by crop for each type of land.

Comparing *kanne* and *dinne* in Table 2, *kanne* shows a higher value for both indices. The fallow ratio is as high as 19.8% for *kanne*, whereas it is only 0.3% for *dinne*. No prematurely decayed land is found in *dinne* at all, but in *kanne*, it is seen in land used for rice, *ragi*, and sugarcane. In particular, this ratio reaches 25.3% for paddy land. Thus cultivation in *dinne* is more stable and intensive.

Table 2 shows another interesting feature of cultivation in *kanne*. Cultivation in *dinne* begins after the first rain of the Southwestern Monsoon, in general at the beginning of June. All the *dinne* land-use units contain growing crops in mid-August, however, at the same time, 10% of the *kanne* land is still being ploughed. Farmers ploughed *kanne* land for the transplanting of rice and *ragi* at the end

2) Blaikie, P. M. [1971] reports the similar concentric pattern of land utilization in a dry farming village in Rajastan. For the general discussion of the pattern of land use around a village, see Chisholm, M. [1979: Chapter 3].

of June, expecting that tank water would be soon available. This expectation was not realized in June and July, 1982, but they remained hopeful and continued to plough the land and bring water in buckets from small muddy pools in the river-bed to keep the seedlings in the nursery beds alive. At the end of August, most of them gave up keeping the land and nursery beds in good condition, realizing that the tank would not be able to supply irrigation water again. *Kanne* nurseries were abandoned and seedlings withered. Only a few farmers who have tube-wells were able to grow *ragi* seedlings in nursery beds in *bhavi thota*. At the end of September, they got sufficient rain to grow transplanted *ragi* by rain-fed cultivation methods. They ploughed their *kanne* land again to transplant *ragi* seedlings from the *bhavi thota* nursery beds (In Fig. 6, this type of ragi cultivation is included in the *ragi* area, not in land being ploughed.). Since the introduction of tube-wells, rich farmers have increased the stability of their cultivation not only in *bhavi thota*, but also in *kanne*. Tube-well introduction is not neutral with respect to the class structure of the village.

IV Contrasts between *Ragi* Cultivation Methods in *Kanne* and *Dinne*

The main cereal crops cultivated in the village are *ragi* and rice, widely grown in *dinne* and *kanne* respectively. Table 2 shows, however, that irrigated *ragi* in *kanne* and rain-fed rice in *dinne* also exist to a lesser extent. The same crops are cultivated in both rain-fed and irrigated conditions. In cultivation methods, though, there are significant differences between *kanne* and *dinne*, in addition to water utilization facilities. We can compare cultivation methods.

1) *Methods of Sowing and Planting*

Table 4 shows the various methods of cultivating *ragi* practiced in the village. They are first divided into irrigated and rain-fed methods, which differ from each other mainly in the sowing and planting techniques adopted; namely transplanting in *kanne* and direct sowing in *dinne*. Although only one irrigated-method, i.e., transplanting method, is found in *kanne*, rain-fed method can be further classified into three varieties by method of sowing; 1. drilling in rows with a seed drill (*kurge*) drawn by a pair of bullocks, 2. hand sowing in furrows cut with a plough, and 3. broadcasting by hand.

Fig. 9 shows the distribution of rain-fed *ragi* in the *dinne* proper, classified by sowing

Table 4 Association of Sowing/Planting Methods of *Ragi* and Minor Crops, Aralamallige

I–1 〔rain-fed——direct sowing〕

minor crops / *ragi*	drilling in rows	hand sowing in rows	broad-casting	dibbling by hand
drilling in rows	X			X
hand sowing in rows		X		
broadcasting	X	X		

I–2 〔rain-fed——transplanting〕

minor crops / *ragi*	direct sowing			
	drilling in rows	hand sowing in rows	broad-casting	dibbling by hand
transplanting		X		

II 〔irrigated——transplanting〕

Only sole cropping of *ragi* is practiced.

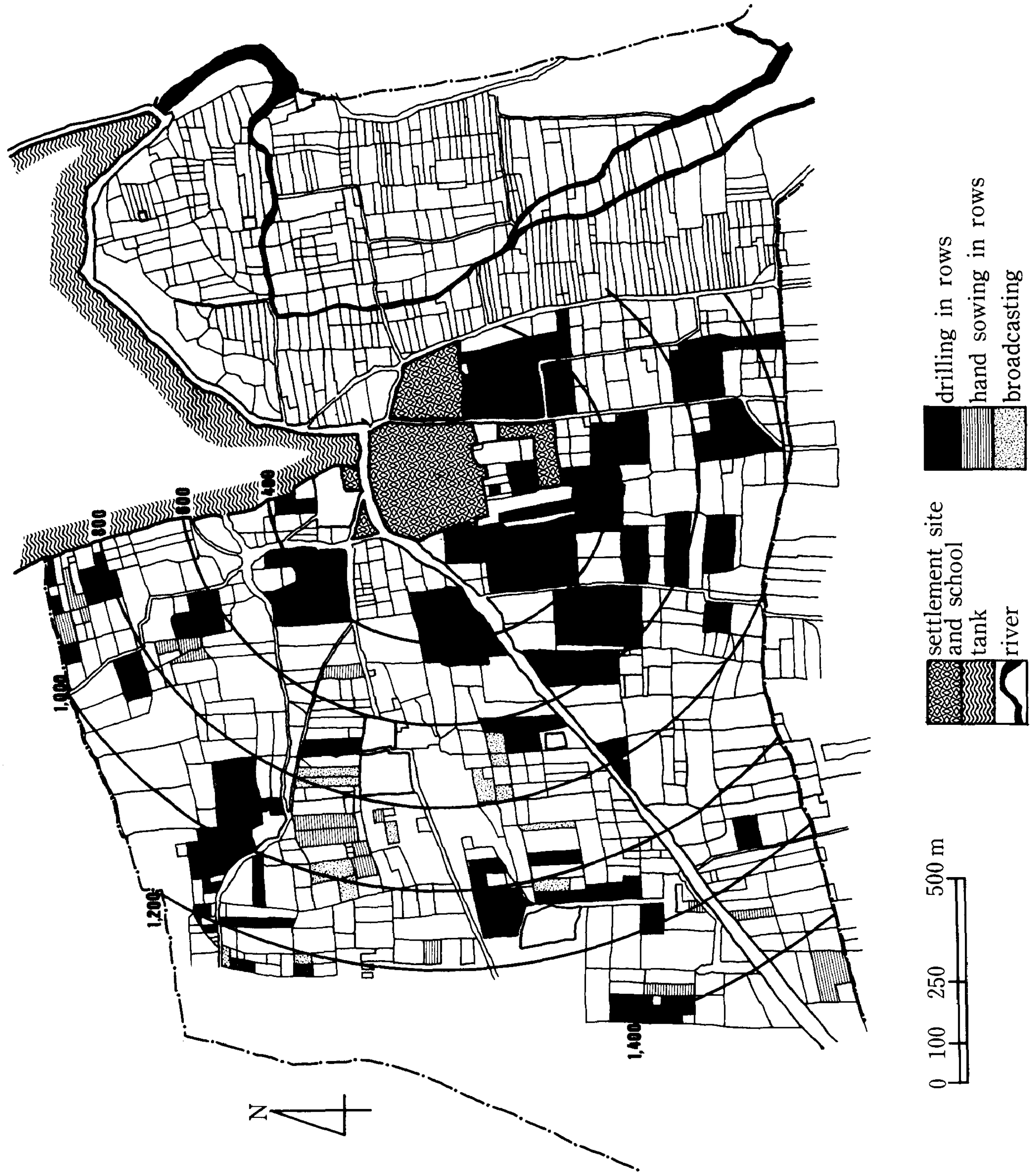

Fig. 9 Sowing Methods of Rain-fed *Ragi* in *Dinne* Proper, Aralamallige

method. *Ragi* grown in *bhavi thota*, which is mainly transplanted, is not included in the figure. The amount of land sown by each method, as a percentage of the total area of *dinne* included in the figure, is 1. drilling in rows, 85.3%, 2. hand sowing in rows, 9.0%, and 3. broadcasting, 5.7%.

If we divide the *dinne* into the same six concentric circles found in Fig. 6, we can calculate the percentage of the total area devoted to *ragi* in each ring sown by each of the three methods. Fig. 10 shows the correlation between these percentages and the distance from the settlement site. Drilling in rows accounts for nearly 100% in the two innermost rings. This method predominates in the other four

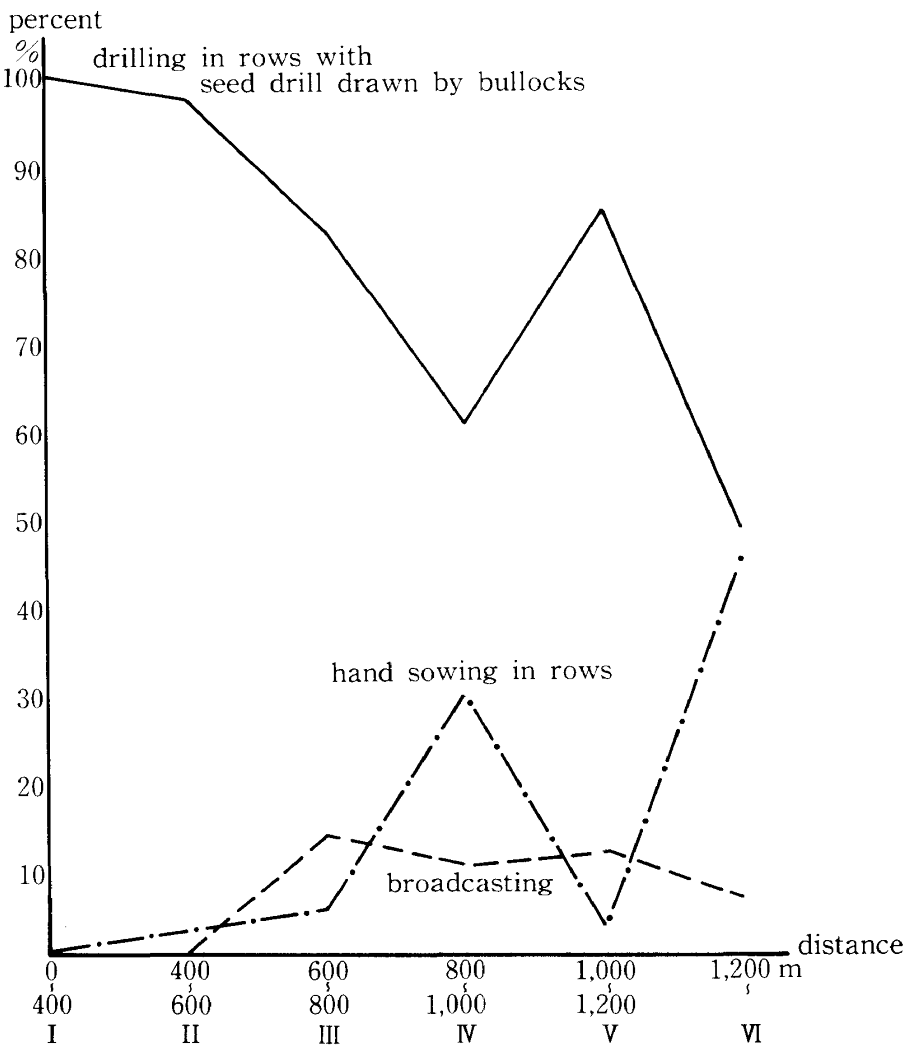

Fig. 10 Percentage of the Total Area of *Dinne* Rain-fed *Ragi* Sown Using Each Sowing Method in Each Ring, Aralamallige

rings too, though its use decreases as we move outwards, except in the fifth ring. Hand sowing in rows, and broadcasting are practiced in the rings further from the settlement, particularly in the fourth and sixth. Both these methods use less labor than the first. We can thus reconfirm the concentric organization of sowing methods adopted in *ragi* cultivation in *dinne* proper, which is similar to the results obtained by the criteria previously discussed.

2) Date of Sowing and Transplanting

In general, there are two rain-fed *ragi* crops according to the date of sowing, *hain ragi* and *kar ragi*. The former, called main-season *ragi*, is normally sown from the beginning of July to the beginning of August. The latter is normally sown in April or at the beginning of May [Aiyer 1966: 43].

In the village, irrigated *ragi* is grown at two times of the year:

1. Sowing in nursery beds at the beginning of April, and transplanting into irrigated fields at the end of April or the beginning of May.
2. Sowing in nursery beds at the beginning of August, and transplanting into irrigated fields at the end of August or the beginning of September.

Both types are harvested three to four-and-a-half months after sowing. Of these, the first, which is also called *kar ragi* in the village, is more widely used in *kanne*, whereas only *hain ragi* is cultivated in *dinne*.

3) Sole Cropping versus Mixed Cropping

Table 5 shows land-use units under *ragi*, classified by the number of crops mixed-grown and type of land. In the *kanne* sole cropping accounts for 13 of the 15 land-use units under *ragi*. Of these 13 units, 11 are irrigated, nine containing transplanted *ragi*, and two being nursery beds. The remaining two are rain-fed owing to tank-water shortages. They are cultivated by rain-fed methods, but feature a sole cropping system, characteristic of irrigated *ragi*. Two *kanne* units feature *ragi* plus one other crop. Both are sown by hand in furrows. Seed drill sowing, typically used for *ragi* in *dinne*, is not practiced in *kanne* at all. *Ragi* cultivation in *kanne* depends on transplanting and hand sowing.

In contrast, rain-fed *ragi* in *dinne*, with the exception of one unit, is always mixed- or inter-cropped.

Furthermore only eight *dinne* units feature *ragi* plus one other crop, whilst the remaining units (93.7%) have *ragi* plus up to seven other crops. Units with mixed cropping of three or four crops make up 55.2% of the *dinne* land used for *ragi* and those with more than five crops, 38.5%.

Fig. 11 shows the distribution of land-use units under *ragi* in *dinne* proper, classified by the number of crops grown. We find no tendency for neighboring plots to have the same number of crops nor can we see a clear correlation between the number of minor crops and the distance from the settlement site.

In addition to the number of crops mixed with *ragi*, one other characteristic of mixed cropping is a rich variety of crop combinations. Mixed cropping consists of a main crop and other minor crops. In the

Table 5 Number of Land-use Units Sole- or Mixed-cropped with Rain-fed *Ragi* by Land Type, Aralamallige

no. of crops / land type	1 (sole cropping)				2	3	4	5	6	7	8	unknown	total
	direct sowing	trans-planting	nursery bed	total	direct sowing*	direct sowing**	direct sowing	direct sowing	direct sowing	direct sowing	direct sowing		
kanne	2	9	2	13	2								15
dinne	1			1	8	32	31	21	11	13	3	1	121
bhavi thota		14	4	18	2	2		2					24
quasi-*kanne*					1	1		1					3
total				32	13	35	31	24	11	13	3	1	163

*: excluding two *bhavi thota* plots which are a. transplanted and b. a nursery bed
**: excluding one *bhavi thota* plot which is transplanted

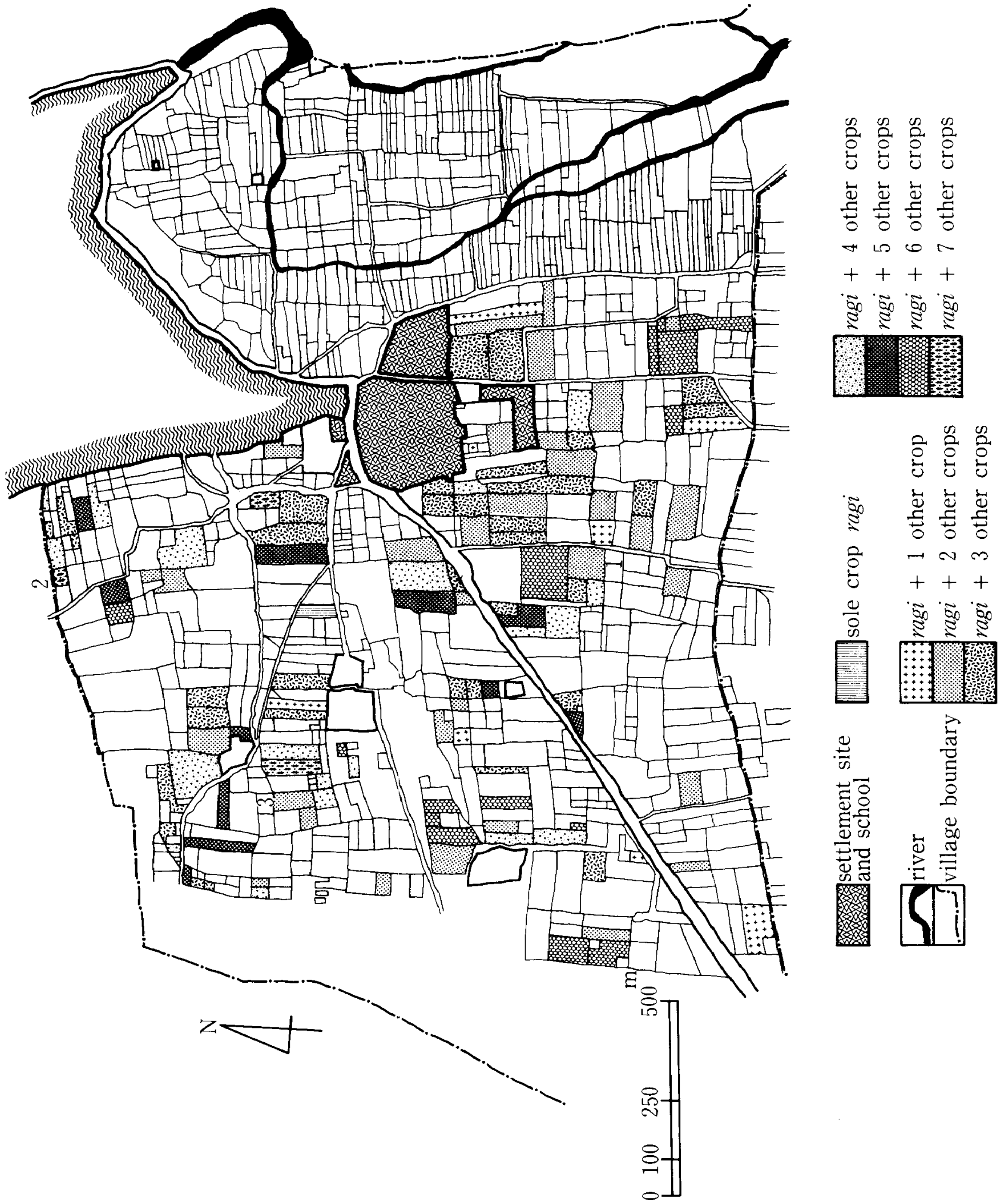

Fig. 11 Number of Minor Crops Forming Mixed Cropping of Rain-fed *Ragi* in *Dinne* Proper, Aralamallige

mixed cropping of rain-fed *ragi*, the minor crops are cereals, green fodder, pulses, oilseeds, and vegetables. The names of these minor crops are as follows:

Cereals: *muskina jola* (maize)

Fodder: *khaki jola* (sorghum, *Sorghum bicolor*) for green fodder

Pulses: *avare* (*Dolichos lablab*), *thogari* (pigeon pea, *Cajanus cajan*), *alasande* (cowpea, *Vigna sinensis*), and *uddu*

		(black gram, *Phaseolus mungo*)
Oilseeds:		*haralu* (castor, *Ricinus communis*), and *huchellu* (niger, *Guizotia abyssinica*)
Vegetables:		*tomato*, and *bende kayi* (okra, *Hibiscus esculentus*)
Condiments:		*menasina kayi* (chilli, *Capsicum annuum*)

Ragi and these 11 minor crops were found in 46 combinations, 26 of which were observed in only one land-use unit. Table 6 shows the details of crop combinations observed for rain-fed *ragi*. The most popular is [*ragi* — *khaki jola* — *avare*] which occupies 26 of the 121 land-use units. Next comes [*ragi* — *khaki jola* — *avare* — *alasande*] which was seen in 12 units. Both of these combinations share [*ragi* — *khaki jola* — *avare*]. This combination is basic to the formation of *ragi* cultivation in *dinne* and 24 of the 46 crop combinations found, occupying 89 of the 121 land-use units, include it.

Minor crops are sown concurrently with *ragi*. In *dinne*, the prevailing method is with seed drills pulled by a pair of bullocks. Generally, two seed drills are used. One, for the main crop, *ragi*, is called *kurge*, and the other, for minor crops, named generically *akkadi*, is called *shadde*.[3] The sowing of *ragi* mixed with other crops requires three men, handling a pair of bullocks, a *kurge* and a *shadde*. The mix can be adjusted by using *kurge* with different numbers of tines and by varying the rows in which minor crops are sown. If they intend to sow only minor crops in a row, the farmers block up one of the holes in the seed bowl of the *kurge* with cotton or small piece of wood.

Mixed cropping with *ragi* does not imply the broadcasting of a random mixture of several seeds. There is both a minimum unit and regularity. When *ragi* is strip-seeded in *dinne*, the minimum unit for mixed cropping is the number of rows equal to the number of tines on the *kurge*, and, especially the central row thereof. Table 6, which shows the various combinations of crops sown, is compiled according to the number of crops per land-use unit. In the total 120 land-use units, as many as 45 types of mixed cropping are observed. However, strictly speaking, mixed cropping or the sowing of minor crops is practiced in the minimum unit of the central row of each series made by the *kurge*. We present only two examples of mixed cropping sown by using *kurge* and *shadde* in Figs. 12 and 13. Fig. 12 shows an example of the most popular mixed-cropping regime [*ragi* — *khaki jola* — *avare*] on land-use unit No. 1 in Fig. 11. Rows run from east to west and a five-tined *kurge* and a *shadde* are used for sowing. Fig. 13 shows an example of an eight crop mix, [*ragi* — *muskina jola* — *khaki jola* — *avare* — *thogari* — *alasande* — *huchellu* — *haralu*] in land-use unit No. 2 in Fig. 11. This is the highest number of crops found in a land-use unit under *ragi* cultivation in *dinne*. A *kurge* with five tines and a *shadde* are used for sowing. As we can see from Figs. 12 and 13, the combinations of minor crops in the minimum land-use unit are much more varied. In particular, as the number of crops concerned increases, more variation is observed in the central row. Thus, mixed cropping

3) For the implements used for cultivating *ragi* in Aralamallige, see Ohji, T. [1979].

Table 6 Mixed Cropping of Rain-fed *Ragi*: Crop Combinations, Aralamallige

no. of crops sown	no. of cases	cereals and millets		fodder	pulses				oilseed crops		vegetables		
		ragi	maize	sorghum	*avare*	pigeon pea	cowpea	black gram	castor	niger	tomato	okra	chilli
1	1	X											
2	3	X		X									
	4	X			X								
	1	X							X				
3	26	X		X	X								
	1	X		X		X							
	2	X		X					X				
	1	X	X						X				
	2	X			X				X				
4	3	X		X	X	X							
	12	X		X	X		X						
	1	X		X	X			X					
	3	X		X	X				X				
	6	X		X	X					X			
	2	X		X		X		X					
	1	X		X							X		X
	1	X			X	X	X						
	2	X			X		X		X				
5	1	X	X	X	X				X				
	1	X	X		X		X		X				
	5	X		X	X	X	X						
	1	X		X	X	X				X			
	1	X		X	X	X							X
	3	X		X	X		X	X					
	4	X		X	X		X		X				
	1	X		X	X			X	X				
	3	X		X	X				X	X			
	1	X		X		X	X			X			
6	1	X	X	X	X	X			X				
	1	X	X	X	X		X		X				
	1	X	X	X	X				X	X			
	1	X		X	X	X	X		X				
	2	X		X	X	X	X			X			
	1	X		X	X	X	X					X	
	1	X		X	X	X		X	X				
	2	X		X	X		X	X	X				
	1	X		X	X		X	X				X	
7	1	X	X	X	X	X	X		X				
	1	X	X	X	X	X	X			X			
	7	X		X	X	X	X	X		X			
	1	X		X	X	X	X	X					X
	2	X		X	X	X	X		X			X	
	1	X		X	X	X		X	X				X
8	2	X	X	X	X	X	X		X	X			
	1	X		X	X	X	X	X	X	X			
unknown	1												

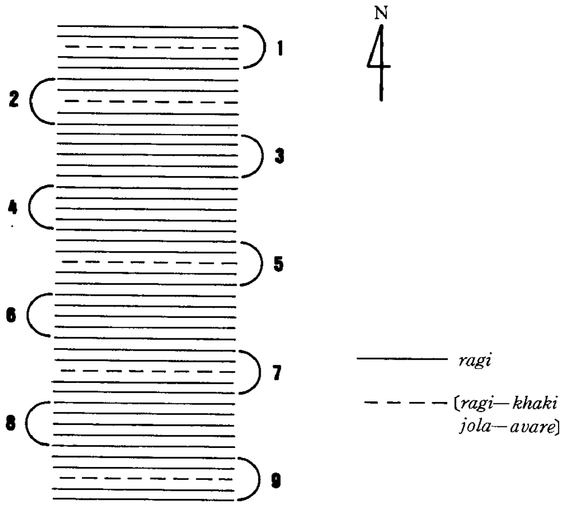

Fig. 12 Mixed Cropping of *Ragi* (1)

with *ragi* in *dinne* should be examined at the level of the maximum land-use unit and the minimum unit, the central row. Even in *ragi* fields sown by broadcasting, minor crops are sown in the plough furrows at intervals of three to three-and-a-half meters, as shown in Fig. 14, which shows land-use unit No. 3 in Fig. 11. Here, too, the minimum unit for mixed cropping is a furrow.

The sharp contrasts between *ragi* cultivation in *kanne* (sole cropping) and *dinne* (mixed cropping) are observed in rice cultivation as well. In the *dinne* tree plantations, various types of mixed cropping are found, especially in the land-use units planted within the last two years.

Thus, mixed cropping is not limited to rain-fed *ragi* cultivation, but forms one of the basic characteristics of the *dinne* cropping system in general.

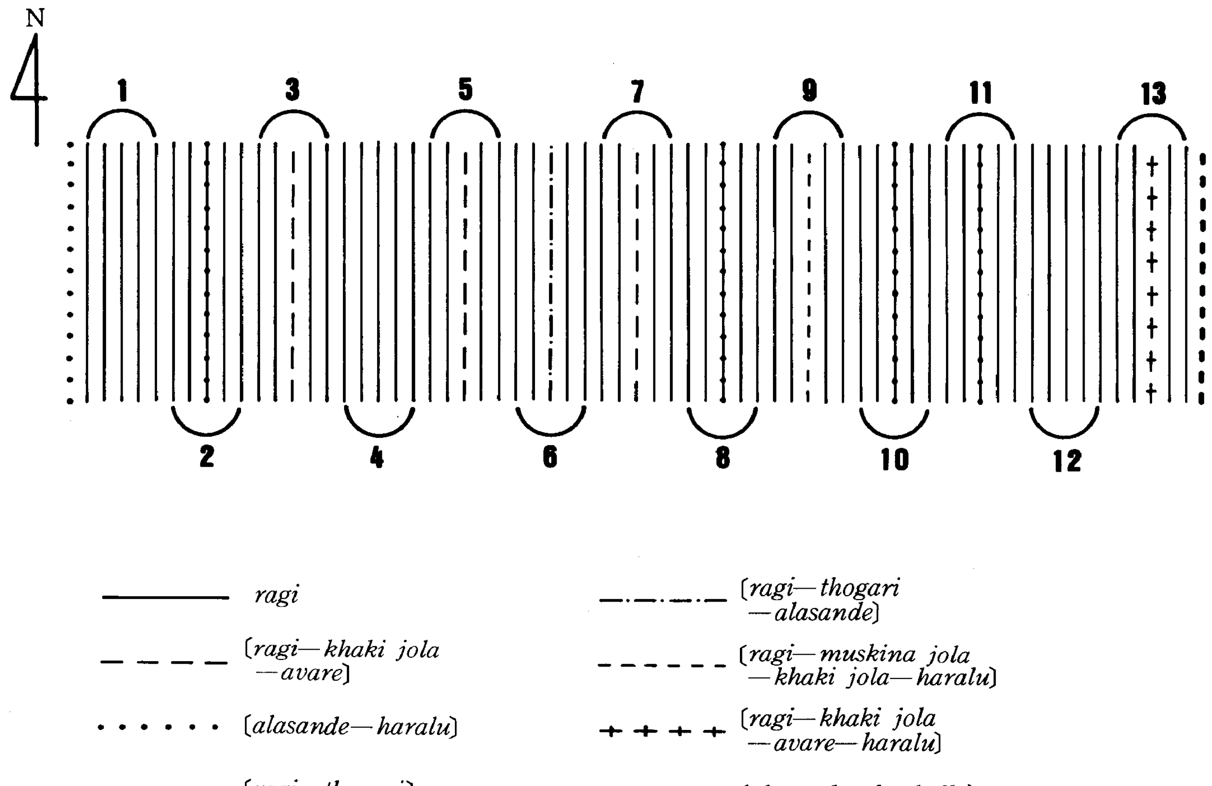

Fig. 13 Mixed Cropping of *Ragi* (2)

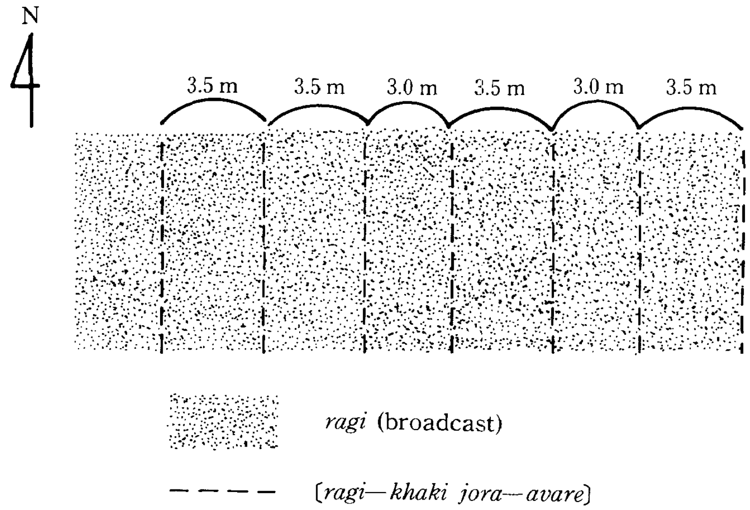

Fig. 14 Mixed Cropping of *Ragi* (3)

4) Interculturing and Weeding

Interculturing and weeding practices are more simple in *kanne* transplanted *ragi* cultivation. The prevailing practice is as follows:

1. Interculturing with a hand-hoe (*gudali*) 30 days after transplanting.
2. First weeding with a hand-weeding implement (*kalekudulu*) 10 days after the first interculturing.
3. Second weeding with the same implement five days after the first.

This completes cultivation. We note that this work is all done by hand, on only three occasions.

For *dinne* rain-fed *ragi*, cultivation is more complicated and intensive. For *ragi* sown with the *kurge*, there are four operations, thinning-cum-interculturing, weeding with an implement pulled by bullocks, hand weeding, and intertillage. All except hand weeding use draught animals. Interculturing and weeding using animal power is rarely seen in the other main areas of millet cultivation in the world.

Interculturing and weeding generally take place the following order:

(1) First thinning-cum-interculturing using a tine-harrow (*kunte*) pulled by a pair of bullocks, 15 days after sowing. At this time, the *ragi* has germinated and begun the initial growth stage. As *ragi* is densely sown, thinning is necessary. This is done with harrows with four, six or eight tines, generally a pair of harrows with four tines each, pulled by bullocks perpendicular to the sowing rows to make thinning more effective. One man manages the handle of each harrow.

(2) Second thinning-cum-interculturing four to five days after the first. Same method and implements as in (1). The only difference is in the number of tines on the harrow. This second stage uses a harrow with four tines. The young *ragi* plants eliminated by thinning at this time are used for complementary planting in the ungerminated portions of the rows.

(3) First weeding using bullocks, 10 days after (2). A special implement called *dharle*, which has four tines and two blades, is used. The blades are attached to the ends of the first and second, and third and fourth tines, and are used to eliminate inter-row weeds whilst the rows of *ragi* pass between the second and third tines. The *dharle* does not interculture the soil, it is only used for weeding.

(4) 10 to 12 days later, the first hand-

weeding. Inter-row weeds are killed with a *kalekudulu* (mentioned above in *ragi* cultivation in *kanne*). If weeds are abundant, they advance the date by a week. This work is carried out mainly by female agricultural laborers.

(5) Second weeding, with a *dharle* drawn by bullocks, takes place four to five days after the above operation, in the same way as in (3), above.

(6) Second hand weeding, a week after the above operation. The method and implement used are the same as in (4).

(7) Intertillage with a *kunte* drawn by a pair of bullocks, 10 to 12 days after (6). A *kunte* with two tines is used. The farmers increase the distance between the tines so that they work between the rows of *ragi*. The *kunte* is drawn parallel to the rows of *ragi* to stir up the soil in the inter-row spaces. This operation is done about two months after sowing, or in the first half of September. At this time, they have the Southwestern Monsoon rains in normal years. Intertillage is done just after these rains and has two purposes, storing rain water in the subsoil as soil moisture, and eliminating inter-row weeds.

In comparison with *kanne ragi* cultivation, interculturing and weeding practices for rain-fed, *dinne ragi* are complex and sophisticated. In the *dinne ragi* plots, they eliminate weeds so completely that we can scarcely find any. With such intensive cultivating methods and the development of a mixed cropping system, continuous cropping of *ragi* is possible in *dinne*.

5) Harvesting

There are certain differences in harvesting methods for *ragi* in *kanne* and *dinne*. In *kanne*, the ears are usually cut with a small hand-sickle. As previously mentioned, transplanted *ragi* in *kanne* starts to ripen from late August to September. This is a period in which *ragi* is in short supply, so farmers select only the fully ripe ears and continue to harvest for many days. This method is used especially by poorer farmers. Richer farmers wait until all the ears are fully ripe, then harvest in the same way. Choice of timing depends on the economic condition of the farmer, but the method is the same.

In contrast, *dinne ragi* is harvested all at once cutting the stalks just above the ground with hand sickles, after the ears and stalks have become fully ripe.

6) Utilization of Stalk

The stalks of *ragi* cultivated in *kanne* are so hard and coarse that farmers do not use them for fodder. After the harvest is finished, the stalks are ploughed into the field or burnt. In both cases the stalks are used for manuring the land.

The stalks of rain-fed *ragi* in *dinne*, however, are used as fodder for bullocks and buffaloes after drying in the sun on threshing floors. Dried straw from rain-fed *ragi* is heaped near cattle huts which are constructed on the outskirts of the settlement.

Another reason why the stalks of *ragi* grown in *kanne* are not used for fodder is that drying them is difficult owing to the coincidence of the harvest season and the rainy season. Cutting and threshing of rain-fed *ragi* in *dinne*, however, take place during the dry season.

The leaves of *ragi* cultivated in both *kanne* and *dinne* are used as green fodder. However, there are some differences in their utilization. In *kanne*, about two weeks after transplanting, the upper-half portion of *ragi* leaves are cut, i.e., leaves some 20 cm in length, and taken to cattle huts as fodder for bullocks, cows and buffaloes.

In *dinne*, in the early vegetative stage, they bring bullocks to the *ragi* fields and let them eat the green *ragi* leaves. Of course the bullocks are not allowed to stay in the same spot but are moved continuously along the rows of *ragi*.

V Concluding Remarks

In this survey report, the discussion has focussed on differences in agricultural landscape and in *ragi* cultivation in *dinne* and *kanne* in Aralamallige. The results obtained are summed up in Table 7 which shows the sharp contrasts between the two land categories created on the basis of water utilization.

Concluding remarks should be made upon the differences of stability of land utilization between them. Fallow land and prematurely decayed land are confined to *kanne*, while *dinne* is used for continuous cropping without crop failure.

These findings are exactly the opposite of what I expected. Why is irrigated agriculture less stable and intensive than rain-fed agriculture in the village? An answer to this question might be sought in the marginal character of irrigation in the South Deccan Plateau, which has a direct association with the climate. The main characteristics of irrigation vary according to the local climate. In the most arid area, with less than 250 mm annual rainfall, cultivation depends solely on irrigation. Therefore, an artificial supply of water is an indispensable basis for agriculture. On the contrary, in the humid area, with more than 1,000 mm annual rainfall, cultivation in the rainy season can safely depend on rainfall. The main regions of irrigated agriculture in the world, exemplified by irrigated paddy, are concentrated in this zone. Here, the basic characteristics of irrigation consist of increasing stability and yields and of enabling farmers to introduce more profitable crops, rather than of providing an indispensable infrastructure for agriculture. These additional effects are achieved if rainfall is reliable. Semi-arid areas, e.g., the South Deccan Plateau, are transitional zones, between the arid and humid ones. Their climatic features include heavy fluctuations in annual rainfall, which makes irrigation, as well as rainfall, unreliable. Moreover, in South Deccan, the predominant traditional method of irrigation is the use of minor tanks, which have a small reservoir capacity and are directly affected by annual fluctuations in rainfall. Village tank-irrigated land has such marginal characteristics that irrigated agriculture is more unstable. On the other hand, rain-fed cultivation in *dinne* is more stable than dry farming in arid regions with rainfall below 500 mm, owing to increased rainfall. South Deccan is an area in which two opposite trends of agricultural differentiation overlap. One is the increasing stability of rain-fed agriculture as we move from arid to humid areas, and the other is the increasing instability of irrigated agriculture as we move from humid to arid areas.

Table 7　Contrasts between *Kanne* and *Dinne*

	Kanne	*Dinne*
〔Agricultural Landscape〕		
1. Water utilization	Tank-irrigated	Rain-fed
2. Geomorphology	Low, flat river plain	Gently undulating upland and slopes
3. Soil	Dark brown soil	Red soil
4. Shape of land-use units	Long and narrow	Square or broad oblong
5. Main crops cultivated	Rice, sugarcane, and betel nut palm	*Ragi*, casuarina, and eucalyptus
6. Spatial organization of land use	North-to-south zones parallel to river and irrigation channels	Concentric zones centered on the settlement site
7. Key factor in the formation of 6.	Reliability of irrigation facilities	Distance from the settlement site
8. Amount of fallow land	Fair percentage	Nil —— continuous cropping
9. Ratio of failed land	Fair percentage	Nil
10. Stability of land utilization	Less	More
〔*Ragi* Cultivation Method〕		
1. Method of sowing and planting	Transplanting in rows, female hand labor	Direct sowing in rows using seed-drills drawn by pairs of bullocks
2. Date of sowing and planting	Late April to the beginning of May	The beginning of July to the beginning of August
3. Crop arrangement	Sole crop	Mixed crop with other cereals, fodder crops, pulses, oilseeds, and vegetables
4. Interculturing and weeding	Less frequent —— mostly three times	Frequent and intensive —— mostly seven times
5. Implements used in 4.	Small hand implements	Large specialized implements drawn by a pair of bullocks and small hand implements
6. Harvesting	Consecutive cutting of individual ears as they ripen	Simultaneous harvesting by cutting near ground level
7. Use of stalks	Manuring	Fodder

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