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both is the measure of relief obtained. Our strong position with reference to opium and gunnies give us a lever with which to lift this passing trouble with Rice.

We trust that this beginning made with the appointment of an officer for the Rice trade though born of a specific distress, will lead to the early maturing of a comprehensive scheme of economic enquiry.

Directorship of Agriculture, Mysore. With the retirement of Dr. L. C. Coleman, M.A., D.Sc., C.I.E. on the 22nd of March last, the Mysore Department of Agriculture, have lost a very valuable officer, and a personality who not only by his administrative capacity, but by his high scientific attainments, made a reputation for himself in the field of scientific workers engaged in Agricultural Research in this country and elsewhere. We wish him in his retirement, sound health and many more years of devotion to scientific pursuits.

To his successor in office Mr. A. K. Yegnanarayana Iyer, M. A., Dip. Agri., we offer our felicitations. A distinguished graduate of the Madras University, Mr. Iyer has had the experience of foreign travel and training, and besides being a chemist, is a reputed authority on Dairying and Economics. He is one of those, who have been taking interest in our Journal and readers will recall his valuable paper on "A century and a quarter of Mysore Agriculture—A retrospect" which he read before the College Day and Conference in 1926. We offer him our best wishes.

A RESUME OF THE INVESTIGATIONS INTO THE SECOND CROP PROBLEM OF THE GODAVARY DELTA*

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Introduction. The Godavary irrigation system comprises the delta portions of the two revenue districts of the East and West Godavary and it supplies water annually for raising two crops of paddy. In most of the irrigation projects of the southern Presidency, a short first crop is closely followed by a long duration second crop; while in the Godavary delta a long duration variety is cultivated between June to November and is followed after an interval of two months by a short duration second crop of *Dalva* (as it is locally known) between February and May. Due to the insufficiency of water supply in the river, between the months of February and April, the area allowed for the *dalva* cultivation is about 28 per cent. of the first

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crop and on the whole comes to about 200,000 of acres, of which the Western Delta alone contributes 125,000 acres.

2. Development of second crop paddy cultivation. *Dalva* cultivation has been in vogue in the district confined to the margin of the Collair lake long before the canal system came into existence in the delta, and was introduced into the delta tract about fifty years ago. As a result of the experience gained by the cultivators from year to year in the early days, the ideal planting season for a good *dalva* crop got fixed to the period between *Bhisma Ekadasi* or as is locally known as *Antervedi Ekadasi* and *Mahasivaratri* corresponding to the second and third weeks of February. A glance at Fig. I. would indicate that this period marks a definite beginning for a favourable change in the weather conditions. Also this period is conspicuous by the steady setting in of the beneficial *pyru gali* (Corn-wind). The crops planted before this crucial stage in the weather conditions either wholly or partly succumb to pests and diseases or at best result in an uneven and poor harvest. By the adoption of late planting in the early days, when dearth for water was unknown due to the comparatively smaller extent under cultivation, bumper harvests were being obtained. Consequently, the area cultivated under the second crop went on steadily increasing to the extent that it passed beyond the safe limits of the average supply in the canal. The great war of 1914–18 and the high price period thereafter, gave a further impetus to the extension of the second crop area in the delta. Naturally, in recent years especially under high level canals and channels, regular and adequate water supply for the crop has begun to be keenly felt.

In the early years when the system was just introduced certain amount of persuasion was said to be necessary on the part of the Government to induce the ryots to take up second crop cultivation. Water was allowed to ryots who preferred applications for cultivating in the second crop season each year before November. After some time even this restriction was withdrawn. In course of time indiscriminate cultivation ensued under the same ayacut some cultivating and some not cultivating. Consequent on this practice, fallow fields in the midst of cultivated areas were affected by the seepage water subjecting them to the ill-effects of wetting and drying, thereby leading to the accumulations of salts on the surface, more especially in saline blocks. Added to the complications of this nature, the area under the second crop was apprehended to be going beyond the commandable limits of the canal supply. To meet the situation a systematic method of allowing second crop was therefore deemed necessary. The Revenue and Public Works Departmental authorities of the district with their executive staff used to sit in conference once a year to decide the channels or portions of channels that should be opened for the next second crop, taking into consideration the legitimate claims

and appeals of representative ryots of the different tracts. Areas where first crop failed either on account of submersion or other reasons and where the first crop is impossible to be grown are always given preference. Such type of lands constitute fairly a large area in the western delta. The unceasing desire on the part of the ryot to grow a second crop, created by the prospect of a double harvest in a year, especially in the post-war period, coupled probably by a few consecutive year of abundant supply in the river, have again jointly and severally contributed to the rise of the second crop area from 66,500 acres in 1900 to 233,000 acres in 1923. In the natural course of events it is no easy task to bring down the area, that once gradually rose, without seriously affecting the economic condition of the district. But Government, however, have a few years back formulated measures to put a check in its further growth through a scheme of localising the second crop area which will be referred to later.

3. Advantages of Second-crop cultivation. Opinion as to whether the second crop cultivation has been advantageous or not is divided. Considering the pros and cons of the question broadly, the majority of ryots seem to feel that the *dalva* cultivation has done comparatively more good than harm to the delta as a whole. At the same time, it must also be admitted that certain inevitable defects are bound to arise in the double crop system of cultivation. It will be presently explained how these disadvantages have been and are being overcome gradually by experience.

It is stated on enquiry that the second crop system has undoubtedly contributed to increased yield in the main crop of the higher delta indirectly by setting up a general awakening in the matter of manuring and secondly by checking the rank growth, the first crop is liable to, when only one crop was grown year after year. Further, the second crop cultivation once in two or three years is said to counteract the *Gulla* or the looseness of the soil in certain areas brought about by either mere single cropping alternated with a long period of fallow or by garden cultivation.

(i). *Increase in cultivable area*: Again, the second crop system is really a blessing to the coastal *parra* or saline lands. But for the development of the second crop system in the delta, the cultivable area in the coastal taluks would not have increased to that extent it had during the last thirty years. It was mainly responsible for an increase in the cultivable area by about 120,000 acres in the western delta alone, during the last resettlement period. In the case of submergible lands and areas where first crop is impossible to attempt, this cultivation offers a chance to raise annually a paddy crop.

(ii). *Increase in fodder supply*: Further the second crop comes always handy to make up the fodder shortage of the cultivators, more especially those of the Eastern and Central deltas, due to the large

areas of cane crop and coconut gardens respectively, the cultivation of which necessitates the maintenance of a greater number of cattle pairs per unit area than for mere paddy cultivation

(iii). *Increase of leases*: It is only after the introduction of the second crop cultivation that the general level of lease for the better class of wet lands is said to have risen from 6—8 bags to 10—13 bags. This high level lease is being paid by the tenants to the land-lords in the hope of getting a second crop once in two or three years. The general yield of 5 to 8 bags that most of the *parra* lands were yielding is also said to have gradually increased to a level of 10—15 bags, as a direct result of taking to *dalva* cultivation.

In the years of plentiful water supply and favourable season, an average yield of 10—12 bags in the second crop in average soils, and 15—20 bags in rich areas growing sunhemp, is usually obtained. Tenant cultivators who are on the increase get very little left (except straw) after delivering the stipulated lease amounts to the land lords and defraying cultivation expenses of the first crop. They naturally look forward eagerly to the second crop which in most cases go wholly to their share. To maintain a high level of lease the landlord is also interested to see that his lands get the second crop turn. It is therefore clear that the *dalva* cultivation was not only directly responsible for the large increase of cultivable area in the deltas but also for bettering the yields of both the higher and lower delta lands though for different reasons. As said before, if the newly reclaimed saline *parra* lands which form the bulk of the area in the coastal taluks are to be improved and maintained in good heart, they have necessarily to be cultivated in the *dalva* season at frequent intervals. Further, in the days of high price for paddy a good portion of the high level lands which was once fit for garden cultivation has been unfortunately lowered to command water supply for the second crop at high costs. As such they have now become unfit for any other cultivation than paddy in the second crop season.

4. Disadvantages of Second crop cultivation. So far we have dealt with the brighter side of the second-crop cultivation and now proceed to consider the two main objections for its continuance, viz., loss due to increase in pests and diseases and deterioration in the fertility of the land. These should always be expected in any system of double crop cultivation. Considering the amount of good that the development of the *dalva* cultivation has brought on, these inevitable defects are not of such magnitude as to decry the system altogether. We think they are within the control of the cultivators themselves to a great extent.

(a) *Pests*— The only pest of importance that the second crop may be said to aid multiplication is the Paddy Stem-borer (*Schœnobius*

incertellus). Statistical data collected by the Government Entomologist in a number of typical centres in the two deltas of the Kistna and the Godavary where single and double crops are cultivated show that the percentage of attack as indicated by the production of white ears (chaffy) varies between 1·71 to 4·37 per cent in a double crop area as compared to 0·2 to 0·58 per cent in a single crop area. This small difference in the percentages is not so alarming as is supposed to be. Study on the incidence of stem-borer carried on at the Agricultural Research Station, Maruteru, for a number of years shows that its effect on the paddy crops in the delta is largely manifested from the end of October to early February. Consequently, the first crop in ears and the second-crop seedbeds and very early planted *dalva* crops are subject to the attack of this pest.

(i) *Effect of stem-borer attack in the first crop season*—In the first crop season the loss is due to earheads turning chaffy or (what is called white ears) if the flowering time of the variety synchronises with the emergence of the borer, while in the *dalva* season the seedbeds and very early transplantations suffer from casualities very often resulting in shortage of seedlings or necessitating a second planting. It will however be interesting to know, how shrewd the delta cultivators by experience have been and are trying to reduce these losses caused by this pest. With the development of the second crop system, some of the late varieties like *Pedda Konamani*, *Gammasari*, *Prayaga* and *Pedda Atragada* that were then extensively grown in the main crop were found to be badly infested with this pest. These have gradually given place to varieties of medium duration such as *Basangi*, *Rasangi*, *Punasa Konamani*, *Akkulla*, *Pala Gummisari* and *Kristnakatukulu* so that the flowering of the crop may just escape the critical period of high infestation. Observations on the appearance of white ears in the first crop season for the last 5 or 6 years at the Research Station show that short duration varieties that flower in August or early September are practically free from the attack. Very stray patches of attack are noticed in varieties that flower about the end of September or early October. With every week thereafter, the percentage of attack becomes more pronounced. A variety susceptible to an attack of 3·13 per cent when flowering on the 29th October showed as high as 26 per cent when it flowered on 12th November. Fig. II representing the emergence of stem-borer moths for a period of one year explains the above phenomena. It is seen that high periodic broods commence to emerge from the very end of October and continue till the end of January or early February

(ii). *Effect of stem-borer in the second crop season*: To counteract the loss of seedlings in the second crop nursery ryots generally sow more than their usual requirements, as then, the area of nursery to be prepared is not a limiting factor; while to get over the heavy casualities

in the transplants they definitely delay planting till the setting in of steady *Pyru-gali* or corn-wind. It has been found by experience that this delayed planting is practically free from the pest. It is also interesting to note that the reasons for a sharp decline and a sudden disappearance of the pest from the middle of February seem to be mostly biological in nature. Egg masses of the pest collected in the month of January under normal conditions hatched out catterpillers, while later collections gradually showed a mixed population of catterpillars and minute Hymenoptrous insects, the proportion of the latter to the former increasing with the advance of the season. Two kinds of insects (*Tetrastichus* and *Trichogramma*) are usually obtained from the collections. The grubs of these wasps are the natural parasites living on the stem-borer egg-masses and the weather conditions alluded to above are perhaps ideal for their rapid multiplication, thereby keeping the pest under control for the time being. It will therefore be seen that the ryots have been admirably adjusting their cultural practices to the altered conditions brought about by the two crop system to dodge the pest by gradully taking to *Punasa* types for the first crop season, and delaying the second crop planting till the pests are biologically brought under control by changed weather conditions.

(b). *Deterioration in soil fertility and increase in alkalinity*: It is admitted on all hands that deterioration in the fertility of the soil is bound to take place in any system of continuous cropping, season after season, with the same crop, without paying adequate regard to manuring, rotation and occasional rest or fallow.

It will be presently seen that the conditions under which the second crop cultivation in the Godavary delta is carried on are such that should not normally prove harmful to the land. The proportion of the area that is cultivated during the second crop season is hardly a third of the area in the main crop and as such only a particular area will get a chance for the second crop cultivation once in three years. This kind of taking an occasional second crop, should, I think, not deplete the soils of their fertility to the extent apprehended by some. In fact, it will give the necessary tone to the texture and structure of the soil for paddy cultivation. Secondly, as pointed out at the outset, the first and the second crops do not closely follow each other in quick succession as in some of the other projects. There is always a fair interval of six to eight weeks between the first and second crop or vice versa. The intense heat of the Circars between 2nd and 1st crops is enough to act beneficially for the following first crop, while the period between 1st and 2nd crop conveniently allows in most of the areas, the taking of a leguminous crop either for manure or for fodder. As a rule, ryots who grow sunhemp after the first crop, turn it down wholly or partly for manuring their second crop. In the case of areas that cannot support a sunhemp crop, *Patti-mannu* or cattle-manure

specially accumulated for the second crop seasons is very largely made use of. Appallingly large and deep excavations of *Patti*-earth deposits in most of the delta villages are in themselves a striking proof of how the ryots have been alert to maintain and increase the fertility of their lands. It has now been definitely ascertained that the interval between the second and the first crop is eminently suited for growing daincha by intersowing before the final draining of the *dalva* crop. A growth of six weeks should be enough to give at least three to four thousand pounds of green matter for incorporation into the soil for the following first crop. This is one of the chief items of Departmental propaganda in the delta. However, it must be stated that the progress in this line is not as much as one should expect due to the frequent set back it receives on account of shortage in water supply to the second crop especially at the end of the season. It is thus evident that under the present system of the *dalva* cultivation in the delta, facilities do exist for maintaining the fertility of the land by way of manuring and rotation with a leguminous crop after a cereal. At the Maruter Agricultural Research Station, two sets of four plots each, are being cultivated with two crops of paddy under manured and unmanured conditions and a review of the yields for three consecutive years represented in Fig. III will show that the yields are being maintained at the optimum level when proper care is taken to supply manure for both the crops. In the case of the unmanured plots, as one should expect, the return in the second crop is poor.

It may then be questioned why then there is still an apprehension in the minds of some people that the second crop system brings about deterioration in the fertility of the land, and increases alkalinity. With the increasing area on the one hand and the anxiety to get a better return by late planting, the second crop could not get an adequate supply of water in the months of March and April especially when the supply in the river was low. Saline soils if subjected to such alternate wetting and drying, would necessarily give rise to an accumulation of salts at the surface of the soil, detrimental to the next crop. Secondly the inadequate water supply at the end of the season does not allow a chance to sow a green manure crop. If in order to get over the shortage of water supply early planting is attempted as in the central delta, the yields get considerably reduced. When the cultivation is carried on under such adverse conditions it cannot but be unremunerative. All the same it cannot be admitted that the dalva system is directly responsible for the adverse effects on the land and yield ; only the system as adopted should be responsible, and needs mending.

Having so far reviewed the different aspects of the second crop system in the Godavary delta at some length, the problem arising out of the present mode of cultivation will next be discussed.

5. The problem of second-crop cultivation. The cultivation of second crop under the conditions now obtained in the delta suffers from a number of disabilities. Attempts at early planting expose the crops to severe borer attack. The survivals take a long time to establish themselves and do not bush out till the weather conditions change for the better. Very often replanting may be necessary or at best may give a very uneven and poor harvest. The crops then are in fact under the mercy of a very fickle season. Seasonal plantings carried on at the Maruter Agricultural Research Station in the beginning of the investigations on the problem strongly confirm the ryots' belief that it is better not to cultivate a *dalva* crop than to attempt at early planting. Marked differences could very easily be observed between the early planted and the late planted crops and the yield figures in Table 1 will bear testimony to this fact.

On the other hand late plantings give a good harvest if water supply is assured. But it is often the experience that most of the areas are said to meet with shortage of water supply at the critical stage of the crop's growth. Sometimes the flowering period may also synchronise with the dry hot westerly winds of Circars if they set in early in the season. Indifferent water supply as pointed out earlier in the paper may contribute to increase the salanity of the soil which in turn adversely affects the following first crop besides a reduction in the second crop yields.

Regular sowings for the second crop do not commence till Christmas or first week of January except in the central delta where ryots are compelled to do so out of necessity as the main canal closes a fortnight earlier there than in the western delta. Planting in its turn could only start briskly from the first or second week of February. Comparatively late planting is still persisted in the higher delta, and that rightly, for three obvious agriculturally sound reasons, viz. (1) the beneficial "corn-wind" that keeps down the stem-borer pest under check, does not steady itself till the beginning of February; (2) the intersown sunhemp crops grown for either fodder or for green manure do not bloom earlier than end of January or early February, and (3) it allows a fair period of interval between the two crops of paddy. Crops planted as late as second and third weeks of February do require water till the end of April. But the supply under Public Works Department regulations, is cut off for *dalva* crop by the 14th of April, in order to fill up village and seed-bed tanks and to irrigate garden crops to tide over the closure month of May. It is in April that the whole trouble is acute as then the demand for water supply is made for a number of purposes, when the supply in the river also runs short and low.

On the other hand the P. W. D. authorities find plenty of supply in the months of December to February and would welcome the

commencement of the second crop cultivation immediately the first crop is over. But Nature is against such a pious wish. Considerable experimental work on the intersown cropping was carried out at the Agricultural Research Station, Samalkot, for a number of years. It was finally concluded that a paddy crop could not be successfully grown in the months of November to January. The problem therefore resolves itself into an attempt at an early harvest, say, by at least a fortnight without prejudice to the stand and yield of the crop at the same time relieving the strain on the canal supply for a free and full distribution to the various other requirements mentioned above, in addition to the further extension of fodder and green manure cultivation during the later part of April.

6. **Regulation of the area as a partial solution of the problem.** The shortage of the water supply for the second crop would become a permanent feature in the delta if the area under the *dalvä* crop is to go on increasing without limit. The Government perceiving this aspect of the question in 1928 formulated definite proposals for localising the second crop area in two main zones in the western division which commands the largest area under the Godavary Irrigation System as detailed hereunder.

i. *Excluded zone*—This constitutes areas permanently excluded for second crop cultivation. They are mostly high level lands difficult to command irrigation under low water conditions.

ii. *Rotation zone*—Areas that should get the turn once in three years.

iii. *Permanent zone*—Areas that are allowed second crop cultivation every year. They are mostly either liable to submersion or those that are not fit for cultivation in the first crop season.

This scheme has been under operation for the past three seasons and has gone far to make up for the disabilities on that account. It now remains for the cultivators also to co-operate in the matter and find ways and means to appreciably hasten their harvest as not to interfere with the supply for other more needy purposes and at the same time ensure a normal average crop for themselves. It is in this matter Agricultural Research should come in to help the cultivator.

7. **Lines of work pursued at the Maruter Agricultural Research Station.** Soon after the opening of the Maruter Agricultural Research Station in 1915, the study of this important problem was taken up for investigation through breeding, culture and manuring.

(a) *Breeding—pure line selection*—It is said that *Nallarlu* was the popular variety in early years when the system was newly introduced in the delta. The increase in area in the two previous decades, which in its train caused crop failures on account of early planting to get

over the inadequate water supply, forced the ryots to look for another variety that could stand comparatively early planting. A variety known as *garikisannavari* found its way into the delta and soon replaced *Nallarlu* throughout the tract except for stray areas in the margins of Collair lake and eastern delta. The local *Garikisannavari* seed is however found to be a bad shedder with very prolonged flowering ranging up to a fortnight. This is a great draw-back in a short duration variety and much more so in one liable to shedding. The early flowering populations would be ripe when the lates are still green. It would keep the ryot undecided about the time for draining the plot for harvest. In order to improve the yield and at the same time bring down the range of flowering to a minimum limit, a number of pure line selections ranging in duration from very early to late were made and studied batch after batch. Along with the yield trials, seasonal trials of the strains were also conducted Very early maturing strains and introduced short duration varieties like Adt. 3, Adt. 4, *Chitrakali* and *Swarnavari* were at their best only when sown and planted later than *Garikisannavari*. Therefore their trial was out of the question for achieving the purpose of an early harvest. Yield trials of strains for five years have resulted in the isolation of a strain, No. 925, which combines better yield and earliness by a week over the local seed. It is in great appreciation even in the trial stage in the district.

(b) *Modifications in cultural practices.*—Periodical plantings conducted altering the rate of sowing, age of seedlings, the method of raising seed bed and spacing in planting gave some valuable information regarding their effect on the flowering of the crop. Planting seedlings from a thin sown nursery, sown at a third of the ryots' rate, was found to hasten the flowering of the crop by about 3 days. As the age of the seedlings sown under swamp conditions increased, the flowering also hastened, but of course, at the expense of yield. However, when the nursery was raised under semi-wet conditions, the stand and yield of the crop were good, with a delay in the flowering. At this stage of these seasonal and cultural trials in 1931, an interesting piece of observation threw further light on the use of aged seedlings, grown under quite adverse conditions.

In the first crop season, a small plot of this variety could not be harvested in time in October due to continuous rains. By then, the crop lodged and its grains germinated on the ears. It was drained late in November for the harvest of the other lots in the plot. Volunteer seedlings appeared as a regular seedbed and were then about nine inches in height. By the end of December, the plot cracked well and the seedlings presented a dried up yellow appearance as though quite unfit for use. On closer examination, however, it was found that within the dried up afle sheaths the seedlings were found to be green. It

was therefore considered desirable to observe the seedlings after planting. Accordingly the seedlings which were then probably over 70 days old, were planted in portion of the nursery area. In spite of such an early planting, as 12th January, and agedness and poor quality of the seedlings, their establishment was remarkable and further growth was quite normal. In the two previous seasons, seedlings that grew under normal conditions when planted at the same time, failed miserably. The crop flowered by the middle of March about a month in advance of the regular delta crop and the final stand also was not below average. From this observation it became evident that seedlings sown in advance and reared under restricted water supply seem to stand the adverse weather conditions and pests better than normal healthy seedlings. Encouraged by this interesting piece of observation, extended trials in the use of seedlings reared semi-dry were conducted in the 1932 season to find the limits of sowing and planting time that would help us to achieve the desired earliness in harvest and at the same time fit in with the existing agricultural practices of the tract without much prejudice to yield. Details of the sowing, planting and flowering data confirm the previous observations made on the crop reared with the volunteer seedlings that such seedlings resist the adverse weather conditions and pests much better than well grown succulent seedlings reared under swamp conditions and also give the expected earliness. Sowings however have to be done quite early to give the seedlings the required hardiness and protective appearance. As the stand of such early planted *dalva* crops depends much upon how the seedbeds are raised and reared, elaboration of this method to suit the season will be pertinent at this stage.

As usual, sprouted seeds are sown in a well puddled and manured nursery. It is reared just like any other normal seedbed up to the time of giving the sprout irrigation, the plot being kept moist up to a period of three or four weeks when enough growth for convenience in pulling (say 9—12 inches) is obtained. Thereafter water supply is cut off completely and the seed beds are allowed to crack to that extent that the seedlings present an yellowish parched up appearance. The chief advantages of drying the nursery in this manner are the seedlings by turning yellow do not seem to attract the moths in such proportion as in a swamp nursery. Casual observations of the egg-mass collections from a dry reared seedbed reveal the preponderance of parasitic wasps. The adverse effects of elongated internodes, that are normally formed when seedlings are not planted in time from a wet seedbed do not manifest themselves under this treatment. On the other hand the nodes get congested. These congested nodes help in the quick rooting and tiller formation soon after planting; and lastly seedlings that are brought up under such adverse weather conditions, when planted in a well prepared puddle strike roots with such rapidity that the crop gets established in a comparatively short time; and even

if the main shoot should be attacked by the borer after planting, secondary shoots are ready to be put forth and thus the heavy casualties that are commonly experienced in early planting of seedlings from a swamp nursery, are considerably minimised.

In the delta soils, pulling seedlings in this type of seedbed is easily and efficiently done without letting in water. The seedlings are better kept over-night in mire for the next day's planting. If in any case, it is apprehended that seedlings are liable to be broken by dry pulling, water may as usual be allowed into the bed before pulling. But it would be necessary to finish the pulling of the whole plot that was so wetted, in a day or two; otherwise the delay would increase the pulling cost, as an irrigation given to the over-dried nursery would induce the seedlings to root quick and deep.

At this juncture, a note of warning is required to a phenomenon that may be observed in planting overaged dry-reared seedlings. Occasionally, a few days after planting, the main shoot may sometimes begin to throw out dwarf ears especially in short-duration varieties. This habit need not be worried about. Vigorous secondary shoots from the congested nodes appear very soon and make up a good stand with a well-covered crop. This method of raising seedbeds is invaluable to tracts where planting time is somewhat indefinite. The common saying that seedlings should be kept in the nursery for as many weeks as the number of months for the duration of the variety would hold good only when the nursery is raised under normal swamp conditions. It can very well be transgressed with suitable modifications when local or seasonal conditions warrant a departure from the normal procedure.

In the second year (1933 season) these trials were, in addition to the repetition of the programme of 1932, extended to bulk scale and regular yield trials with very satisfactory results. The results confirmed the first year's trial and the following tentative conclusions could also be arrived at.

(i) Permanent *dalca* areas that are not cultivated in the first crop season or areas where the first crop is damaged by submersion, can be planted in the first or second week of January with seedlings sown in November and treated above. Irrigation may be cut off by the end of March.

(ii) Areas that are cultivated in the first crop season, but kept under *muzagi-thammu* (continuous puddle) require a short period of rest before planting the second crop. They are fit for planting only after *Pongal* in the second week of January. Sowing for these areas should be done by about the end of November or early December.

The harvest would take place in the second week of April and water may be cut off by the first week of April.

(iii). Areas that usually grow catch crops of sunhemp may wait till the end of January or first week of February for sunhemp to grow well and planting begun in the first or second week of February, provided the seed beds are sown early in December and kept in a dormant condition till planting. The crop may come for harvest by the third week of April and the irrigation for these areas may be cut off by the second week of April. Comparative yield data of a crop planted by the new method with that of the normal practice are presented in Table 2.

(c). *Manuring*—In agricultural practice, the output of any crop is invariably sought to be increased by means of manuring. However, it is not uncommon to hear of disappointments in taking to a particular manurial practice due to the yields having fallen short of expectations. Ascertained increases in yield due to a particular manurial treatment for a crop in one place cannot always be expected in another place. Manuring has therefore to be regulated to the nature of the soil, season, crop and varieties.

It is common experience that response to manuring is better perceived in soils of low fertility than otherwise and will therefore pay to manure soils of low fertility. The effect of a manurial treatment in the first crop season in the Godavary delta is invariably masked in a favourable season, say, rainless summer followed by early freshes in the canal with periodic wet weather in the growing period of the crop. In soils of average fertility an unmanured plot gives then almost as much as a manured plot, and the slight differences that exist will be but negligible. In such good seasons it is more likely that manuring will affect the crop adversely due to the rank growth it may cause. Crops highly manured require topping as otherwise they prelodge if left to themselves, with consequent reduction in yield and quality of the produce. It is in years of unfavourable weather and late planted conditions that the effect of manure is seen in the first crop season in the delta. Again, the effect of manure under similar conditions is bound to vary with the varieties of the same crop of differnt durations. It is a matter of common experience in the delta that short duration varieties in the first crop season respond to manuring or to the inherently high fertility in a soil better than a long duration variety. The yields of *Basangi*, a 5 months variety, have been ranging between 3,500 to 4,500 lbs., while that of late varieties as *Kristnakatukulu*, *Atragada* and G.E.B. 24 of 6 to 6½ months' duration varied between 2,800 to 3,500 lbs. per acre. It is for this purpose that ryots prefer to cultivate *Basangi or Rasangi* in both the rich and early planted areas. Seasonal factor thus plays a very prominent part in determining the yield of the first crop of the Godavary delta much more than manuring.

In the second crop season the story is entirely different. All the three factors favourable for the manure to play its part namely, the shortness of the duration of the variety cultivated in the second crop season, the absence of favourable seasonal influence and the exhausted condition of the soil after the removal of the first crop paddy, exist. A review of the two years' yield data presented in Table 3 for both the crops strongly point out the very good effect of manuring directly for the second crop. In this connection attention is drawn to Fig. III registering the striking differences in the bulk yields of manured and unmanured plots in the second crop season compared to the first crop. In further corroboration of the big differences that are obtained by manuring the second crop, the two-year results of a preliminary manurial experiment with green-manure and ammonium sulphate are set out in Table 4.

It should therefore be our effort to recommend to the delta cultivators to conserve their manurial resources for the second crop or short-duration varieties and late planted crops in the first crop season to obtain the maximum return for their use. In the higher delta and in the better class of lands in the lower delta, sunhemp is grown between the first crop and the second crop season for fodder purposes. Careful ryots who have realised the advantages of manuring their *dalva*, turn under this catch crop wholly or partly and they are sometimes said to obtain better yields than in the first crop season.

It would be really valuable to the delta ryots who annually cultivate nearly 200,000 acres in the second crop season to know which of the large group of manures that are now available in the market is going to give them a maximum profit with the minimum outlay. The necessity for starting a comprehensive manurial scheme in the second crop season is apparent and proposals for the same were put up and the continuance of the "Subsidized Manurial Trials" for another three years is very desirable.

(d). *Seed preservation:* So far improvements in the cultural and manurial aspects of the second crop cultivation have been detailed and the problem connected with its seed preservation and supply will be hereafter considered. The seed of the second crop harvested in May is not kept over for the next second crop sowing. An intermediate seed crop is as a rule raised in the first crop (June—October). This seed crop invariably suffers from a wet harvest. On this account it is not every body that ventures on taking a seed crop and even if one does, he cannot command the harvest of large areas in the monsoon months. It is therefore confined to those favoured few who have facilities for harvesting and threshing the crop in the short spells of clear weather. The area grown being thus limited and the demand being large, the price of *Garikisannavari* seed harvested in October goes up to 5 or 6

rupees per bag when ordinary paddy is being sold between 2½ to 3 rupees, even in these days of acute depression.

In spite of the fact that the price to be paid for seed is exhorbitantly high and knowing that the seed that has not had a sufficient period of rest gives a comparatively less uniform growth than the old seed, ryots prefer to go in for the seed from the new harvest. The reason for this practice is said to be due mainly to the very low percentage of germination obtained in seed stored through the two monsoons (June - December) under ordinary methods of storing. Vitality experiments of such a seed conducted on the station bear clear testimony to the above observation. Impaired vitality being the chief concern in the problem, it should be possible to reduce the outlay on the seed in the cost of the second crop cultivation, if better methods of preserving the cheaply available seed of the May harvest are found out. Experiments on the different methods of seed preservation were taken up along with the varietal, cultural and manurial experiments dealt so far. A perusal of the results of the storage and vitality experiments set forth in Table 5 will clearly show that seed preserved in metallic receptacles (Kerosine tin and Galvanized bins) maintain their vitality quite well until required for sowing through the monsoon months. On the other hand, seed stored in gunnies either single, double and even treble or fourfold begin to lose their vitality from about the fifth month. The basket bin and *mudicatta* (bundle made of straw twists) are intermediate between the two extremes very often depending upon the material and the make. Incidentally, it was noticed that longer initial soaking of seed material improves the percentage of germination. Side by side, comparative yield trials of new seed versus old seed preserved properly were conducted. They have given very clear proof that old seed is not in any way inferior in its yields, but combines with it an even harvest which is a great desideratum in a short-duration shedding variety. However, the initial cost on the purchase of the metallic receptacles (though in most cases it would be equal to the first year's saving in the cost of the seed) may stand in the way of their extended use. But a short reflection on their permanent utility compared to the more common articles of storage should clear this doubt. In the course of these experiments it was also noted that when seed preserved in gunnies was given occasional dryings, an improvement by way of increased percentage of germination (vide Table 6) was obtained. It does not however approach the percentages secured in the seed preserved in metallic receptacles. It is hoped that further observations in the number and the frequency of dryings that should be given to improve the quality of seed material may help to bring the solution of the problem within the range of practical utility by the ryots.

(e) *Prophylactic measures against "Foot-rot" disease of paddy*— During the course of these investigations just mentioned, a disease

identified as "Foot-rot" of paddy made its appearance in the 1930 second crop in an epidemic form affecting nearly fifty per cent of the transplanted population. Preliminary studies on this disease showed that it could be easily brought under control with some precautions. In bulk crops where planting is mostly done in doubles or trebles due to the poor growths of *dalva* seedlings in the nursery, the appearance of the disease is not very much felt on the yield. In a clump where one of the seedlings is affected the second plant is invariably observed to be free from infection. Therefore the uninfected plants make up the final yield. As a result of some preliminary experiments conducted by the Government Mycologist at the Station, steeping seed in 2 % copper-sulphate solution for 30 minutes was found to be most efficacious of all the treatments, considering the cost, facility of handling, etc. Ever since, seed treatment has been adopted as a routine measure for all the sowings on the station, and it could not be said that systematic seed treatment has brought the disease sufficiently under check. Detailed investigations on this disease in search of a still better control measure than the above are being carried on by the Government Mycologist at his headquarters.

8. Summary. Commencing with a comparison of the two crop system of the Godavary irrigation with some of the other projects of the south, the paper traces its growth and its effects on the economics of the delta. It points out how the benefits by way of increases in yields, rates of leases, fodder supply and the cultivable area, outweigh some of the inevitable and remediable disadvantages as continued multiplication of pests in the tracts, deterioration of soil fertility, and increase in alkalinity.

Thereafter the problem of obtaining an early harvest without prejudice to yields to get over the two main limiting factors, adverse seasons and pests for early planting, and shortage of water supply for late plantings, is discussed. If this should be possible it would incidentally encourage an extension of garden, fodder and green manure cultivation in the delta.

Finally, the various lines of work taken up to tackle the problem are detailed trials of very early maturing strains and short duration varieties like Adt. 3, Adt. 4, *Chitrakali* and *Swarnavari*, proved a failure. A promising strain of *Garikisannavari*, No. 925, which combines a week's earliness and better yield than the local has been isolated. Trials in the modification of raising seedbeds initially under semi-wet and later under dry conditions have so far been found to be encouraging. Seedlings thus raised stand early planting and come for early harvest without prejudice to yields. The results of a few experiments with green manure are concisely brought out to show that it is more remunerative to manure the second crop than the first crop. Dealing with seed preservation, it is found that the May-harvested

seed is quite viable to be fit for next second crop sowing in December only when preserved in metallic receptacles. The very poor quality of seed stored in gunnies is found to improve to some extent in their viability by occasional dryings during the period of storage. The paper concludes with a remark on the efficacy of seed treatment with 2% copper-sulphate as a prophylactic measure against "Foot-rot" of paddy.

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Table 1.

Statement showing the effect of early and late planting in the second crop season on the final yield.

Dates of sowing.	Dates of planting	Age of seedlings.	Average yield in decagrams per strip of 40′ × 4′.
16th December	19th January	35	454
23rd "	27th "	"	631
31st "	4th February	"	676
14th January	14th "	30	752

Table 2.

Statement showing that yields are not affected by agedness of seedlings by comparison of bulk yields of crops raised by the modified methods of seed-bed culture against normal practice.

Treatment.	Dates of			Yield per acre in lbs.
	Sowing.	Planting.	Flowering.	
Normal practice of late sowing and late planting.	3rd Jan.	10th Feb.	12th–16th April.	2684
By the modified seedbed culture, early sowing & planting.	30th Nov.	2nd Feb.	23rd Mar.	2846

Table 3. Results of the experiments with green manure on the first and second crop showing the significant increases in yields in the Second-crop season.

Particulars of treatment.	Results in the 1st crop.				Results in the 2nd crop.				Remarks.
	Total yield in ozs. of 5 repts.	%age increase over no manure.	%age of grand mean.	Standard error as %age of grand mean	Total yield in ozs. of 5 repts.	%age increase over no manure.	%age of grand mean.	Standard error as %age of grand mean	
1931—32.									
Both crops green manured at 4000 lbs. each.	799	98·4	98·4	7·1	714	148	126	3·75	
Main crop alone green manured at 4000 lbs.	838	103	103		510	106	90		
No manure for both the crops.	815	100	100		481	100	85		
1932—33.									
Both crops green manured at 4000 lbs. each.	766	108	108	3·6	752	136	122	3·12	
Main crop alone green manured at 4000 lbs.	643	90·6	90·6		542	98	88		
No manure for both the crops.	709	100	100		553	100	90		

Table 4. Results of manurial experiments in the second crop season under different treatments.

Treatment.	1931—32.				1932—33.				Remarks.
	Average yield in decagrams per plot.	% with reference to no manure.	% of grand mean.	Std. error as % of grand mean.	Average yield in decagrams per plot.	% with reference to no manure	% of grand mean.	Std. error as % of grand mean.	
1. No manure.	516	100·0	85·4	1·79	428·2	100'0	79·11	2·72	
2. Dry sunhemp at 2000 lbs. per acre.	636	123·3	105·3		571·7	133·6	105·6		
3. Ammonium sulphate at 100 lb. per acre.	568	110·0	93·9		510·7	119·3	94·36		
4. Sunhemp green at 2000 lbs. plus Ammonium sulphate at 100 lb. per acre.	673	130·4	111·3		610·2	142·5	112·7		
5. Sunhemp green at 2000 lbs. plus Ammonium sulphate at 100 lb. in two doses per acre	663	128·4	109·6		606·0	141·6	111·9		
6. Ammonium sulphate at 100 lb. per acre in two doses.	571	110·6	94·4		521·0	121·7	96·25		

Table 5. Results of germination tests of *Garikisannavari* seed under different methods of storage.

Mode of storing	Percentages of germination.			
	Laboratory test.		Field test January 1931.	
	6th Nov. 1930.	14th Dec. 1930.	Seed soaked for 24 hours before draining and keeping for germination.	Seed soaked for 36 hours before draining and keeping for germination.
1930—31.				
Second crop seed—May harvest—				
Bin-made of galvanised sheet.	—	99	63	80
Kerosine tin.	—	98	63	86
Basket bin.	—	99	30	22
"Mudikatta" plastered.	—	89	36	54
Do. non-plastered.	—	90	38	54
Gunny—single.	81	—	10	11
" double.	84	—	13	10
" treble.	92	—	12	10
" fourfold.	90	—	10	8
Control—October harvest—	—	—	86	—
1931—32.				
Bin-made of galvanised sheet, stored full.	—	99	77	86
Do. to a fourth.	—	95	70	92
Kerosine—tin-stored full.	—	98	75	92
Do. to a fourth.	—	91	60	86
Basket-bin.	—	90	37	57
"Mudikatta" plastered.	—	12	1	3
Do. non-plastered.	—	71	11	30
Control—seed harvested in October.	—	—	59	73

Table 6. Results of the vitality test of *Garikisannavari* seed stored in gunnies with and without drying during the period of storage.

Particulars of treatment.	Percentage of germination conducted in January					
	Laboratory test			Field test.		
	Single gunney	Double gunney	Treble gunney	Single gunney	Double gunney	Treble gunney
Second crop seed–May harvest.						
Non-dried during the period of storage.	28	32	34	12	14	11
Dried once.	32	80	82	29	36	37
" twice.	67	71	92	31	37	31
" thrice.	78	87	86	31	34	34
Main crop seed–Oct. harvest.						
Control.	95	—	—	55	—	—