

2nd revised edition

Practical Manual on Basic **Agronomy**

(with theory)



N. R. Das



SCIENTIFIC
PUBLISHERS



Practical Manual on **BASIC AGRONOMY** (with theory)

2nd Revised Edition

Professor N.R. Das

M.Sc. (Ag.), Ph.D., D.W.P. (CIMMYT-MEXICO), FIBR (INDIA)

*Ex-Professor of Agronomy,
Bidhan Chandra Krishi Viswavidyalaya,
Mohanpur, Nadia, West Bengal*

Formerly,

Director of Research, Director of Farms and Head, Department of Agronomy;
Faculty of Agriculture, Wheat Agronomist and Officer-in-Charge, All-India Co-ordinated
Wheat Improvement Project (ICAR) and Research Agronomist,
Bidhan Chandra Krishi Viswavidyalaya, West Bengal



Published by
SCIENTIFIC PUBLISHERS (INDIA)

Jodhpur –

5 A, New Pali Road
P.O. Box 91
Jodhpur - 342 001 INDIA

2nd Revised Edition: 2018

All rights reserved. No part of this publication or the information contained herein may be reproduced, adapted, abridged, translated, stored in a retrieval system, computer system, photographic or other systems or transmitted in any form or by any means, electronic, mechanical, optical, digital, by photocopying, recording or otherwise, without written prior permission from the publisher. Any breach will attract legal action and prosecution without further notice.

Disclaimer: While every effort has been made to avoid errors and omissions, this publication is being sold and marketed on the understanding and presumption that neither the editors (or authors) nor the publishers nor the printers would be liable in any manner whatsoever, to any person either for an error or for an omission in this publication, or for any action to be taken on the basis of this work. Any inadvertent discrepancy noted may be brought to the attention of the publisher, for rectifying it in future editions, if published.

This book contains information obtained from authentic and highly regarded sources. Reasonable efforts have been made to publish reliable data and information, but the editors and publisher cannot assume responsibility for the validity of all materials or the consequences of their use. The editors and publisher have attempted to trace and acknowledge the copyright holders of all material reproduced in this publication and apologize to copyright holders if permission and acknowledgement to publish in this form have not been obtained. If any copyright material has not been acknowledged please write and let us know so that we may rectify it.

Trademark Notice: Publications or corporate names may be trademarks, and are used only for identification and explanation in bonafide intent without intent to infringe.

ISBN: 978-81-7233-584-7

eISBN: 978-93-8786-981-3

© Das, N.R., 2009

Visit the Scientific Publishers (India) website at
<http://www.scientificpub.com>

Printed in India

*In memory of my teacher late
Professor A.T. Sanyal, Professor of
Agronomy, the then Kalyani University,
West Bengal who inspired me for the
field-work activities.*

— Author

PREFACE

There is a proverb, “*Practice makes a man perfect*”. From this proverb, it is obvious that confidence which is created out of regular practice anything, ultimately is very helpful for future life and this is true in case of agronomic practice also.

India is a vast country, having different ecosystems, with different plants, animals and human population. Under the prevailing situations, it is quite natural that most of the people of eastern India do not know anything about the plant of ‘*isophgol*’ (*Plantago ovata* Rosk, of *Plantaginaceae* family), though they use it as medicine; on the other hand, most of the people of the western parts of the country, do not know the fibre crop of ‘jute’ (*Corchorus olitorius/capsularis* L. under *Tiliaceae* family), though they use the jute bag/ sack/carpet etc. But students of agriculture in both the areas, should at least, to be acquainted with some of the information of both the plants, though it is not possible to look at them in their respective areas, due to different ecosystems.

The ‘*farm*’ where agronomy students do the practical class, is a holy place, and from there they can learn many many things which ultimately will be the assets in life. Therefore, agronomy students should visit the farm, of course, with the permission whenever they get time, besides their classes, to increase their knowledge in crops, soils, meteorological aspects or other management practices. Of course, for visiting farms, inquisitiveness or special interest is needed.

For creating such inquisitiveness, the ‘*farm*’ should be arranged in such a way, where office-buildings, threshing floors, equipments/tractors/tools sheds, crop museum, irrigation systems, godowns (for seeds and fertilizers), open laboratories, well laid-out fields, good neat and clean beautiful gardens, good pucca road/path, effective machineries, electricity etc. are available.

For good teaching or learning, a good ‘*farm*’ is essentially needed, with good knowledgeable and work-interested field staffs, along with the interested teachers.

Theoretical knowledge or the background information of the subject, is also required for practical work. With this in view, the present book, entitled, ‘**Practical Manual on Basic Agronomy**’, has been written in short, as a ‘practical text book’ in Agronomy subject, based on theoretical background, for thorough knowledge of that subject, after a long teaching experience in the universities. Practical classes, with lesson numbers have been fitted,

immediately after theoretical discussions, in different sub-chapters in Chapters, on the same studies. The lesson, has been divided into 'Introduction', 'Objective', 'Materials required' and 'Procedure'. In some cases, 'assignments' have also been given.

There are 14 chapters in this book and these are: 1. Introduction, 2. Preliminary knowledge for Agronomy studies, 3. Climate and its influence on crop production, 4. Soil environment and its modification for crop production, 5. Tillage and crop production, 6. Seeds, sowing, stand establishment and crop-classification, 7. Manures and fertilizers for crop production, 8. Irrigation for crops and cropping systems, 9. Weeds and weed-management for crop production, 10. Soil moisture management under rainfed conditions, 11. Major crops cultivation (in short), 12. Cropping systems, 13. Harvesting of crops, crop-yields and their storage and 14. Vital information for practical approach. Besides these, there are 170 lessons in it.

For all the students of 4-year-degree courses in all the agricultural universities of the country, this book will be needed. This will be very helpful for other students of agricultural training centres/research institutes of different states of the country also. In different 'Krishi Vignan Kendras (KVK)' of ICAR, this type of book will be required for their training programmes. Even the educated farmers will also be benefited for their upliftment of crop production programmes, with this book.

I thank those persons, who have requested me to, write such a new type of book, for the development of 'teaching-in-agriculture' of the country. At the end, I am thankful to my son Partha, daughter Aparna and wife Arati who have helped me directly or indirectly, in writing this book.

N.R. Das

Sabuj Niketan,
Kalyani, West Bengal

LIST OF LESSONS UNDER PRACTICAL CLASSES

(Lessons 1 to 170)

| Lesson | Page |
|--|------|
| Lesson 1. Visit to the University Farms (for studies on land situations, soil types, crop grown, area, overall assessment of the farms about the infrastructure facilities and surroundings) | 10 |
| Lesson 2. Visit to the ICAR Research Institute Farms (for studies of land situation, soil types, crops grown, area, overall assessment of the farms about the infrastructure facilities and surroundings) | 11 |
| Lesson 3. Visit to the State Govt. Farms (for studies of land situation, soil types, crops grown, infrastructure facilities, overall assessment of the farms infrastructure facilities and surroundings) | 11 |
| Lesson 4. Identification of common seeds/agronomic seeds of field crops like (a) cereals, (b) pulses, and (c) oil seeds. | 15 |
| Lesson 5. Identification of common seeds/'agronomic seeds' of field crops of (a) fibres, (b) sugars, (c) tubers and (d) fodders. | 16 |
| Lesson 6. Identification of common organic manures. | 23 |
| Lesson 7. Identification of common chemical fertilizers. | 25 |
| Lesson 8. Identification of cereal crops like rice, wheat, maize, barley, <i>jowar</i> , <i>bajra</i> and oat. | 31 |
| Lesson 9. Identification of pulse crops [lentil, greengram, blackgram, redgram (<i>arahar</i>), gram and grasspea and pea]. | 33 |
| Lesson 10. Identification of oilseed crops (Mustard/rape, groundnut, sesame and sunflower) | 33 |
| Lesson 11. Identification of fibre crops (Jute, cotton, mesta, sunnhemp and flax). | 33 |
| Lesson 12. Identification of sugar crops (sugarcane, sugarbeet, yambean and sweet potato) | 33 |
| Lesson 13. Identification of tuber crops and rhizomes, [Potato, elephant-foot-yam (<i>amorphophalus</i>) (ol) and arum] | 33 |
| Lesson 14. Identification of fodder/forage crops : <i>Legume group</i> – Berseem, lucern, ricebean, grasspea, cowpea and blackgram) and (b) <i>Non-legume group</i> – Napier, thinnapier, teosinte and dinanath grass. | 33 |
| Lesson 15. Identification of general farm implements and drawing the hand tools and labelling them. | 41 |
| Lesson 16. Drawing the <i>desi</i> plough and mouldboard plough and describe and label them. | 42 |
| Lesson 17. Running both the <i>desi</i> plough and mouldboard plough in the field for wheat sowing and record the differences 30 days after sowing and at harvest. | 45 |
| Lesson 18. Wheel hoe running in the wheat fields, immediately after application of N-fertilizers, as top-dressing | 46 |

| | | |
|------------|--|----|
| Lesson 19. | Running the paddy weeder for removing weeds in transplanted <i>kharif</i> rice | 47 |
| Lesson 20. | Dismantling and mantling the single row seed drill (jute seed drill) after drawing and labelling each part. | 48 |
| Lesson 21. | Practising the running of the sprayer for plant protection (weed control) measures cautiously | 49 |
| Lesson 22. | Identification of different broad and narrow-leaved weeds with scientific names in <i>rabi</i> season | 53 |
| Lesson 23. | Identification of some broad and narrow-leaved weeds with scientific names in pre- <i>kharif</i> season | 55 |
| Lesson 24. | Identification of some broad and narrow-leaved weeds with scientific names, in <i>kharif</i> season, along with the family and natures. | 56 |
| Lesson 25. | Identification of sedges with scientific names, family and nature, in different seasons | 58 |
| Lesson 26. | Identification, with scientific names, the obnoxious weeds of wheat crop (wild oat, <i>phalaris</i> and <i>temulentum</i>) in wheat fields with sketches) | 58 |
| Lesson 27. | Identification of the meteorological major instruments with diagrams/ sketches | 64 |
| Lesson 28. | Showing of the meteorological international symbols of (a) Dew, (b) Rain, (c) Fog, (d) Snow, (e) Drizzle, (f) Shower, (g) Continuous slight rains, (h) Continuous heavy rains, (i) Hails, (j) Cloudy weather, (k) Thunder storm, (l) Lightning (m) Partly cloudy, with drawings | 65 |
| Lesson 29. | Growing of <i>dhaincha</i> and ploughing - under it, in pre- <i>kharif</i> season (elaborate it fully) | 69 |
| Lesson 30. | Growing of grasspea and ploughing-under it in <i>rabi</i> season (elaborate it fully i.e. write the procedures for GM (green manure) | 71 |
| Lesson 31. | Growing of <i>guar</i> for G.M. (green manure) and ploughing - under it, in <i>kharif</i> season (elaborate it fully i.e. write the procedure) | 71 |
| Lesson 32. | Observations, on weed-behaviour of obnoxious weeds of (a) <i>Phalaris minor</i> , (b) <i>Avena fatua</i> and (c) <i>Lolium temulentum</i> in wheat in <i>rabi</i> season | 73 |
| Lesson 33. | Studies of the growth behaviour of <i>Physalis minima</i> in (a) <i>rabi</i> , (b) pre- <i>kharif</i> and <i>kharif</i> seasons, with associated crops | 74 |
| Lesson 34. | Growth records of wheat crop, in general, for assessing soil fertility in <i>rabi</i> with 1-10 scale | 81 |
| Lesson 35. | Growth and visual observations of <i>aus</i> rice, for assessing soil fertility in pre- <i>kharif</i> season | 82 |
| Lesson 36. | Growing wheat crop in (a) one plot without organic matter and (b) one plot with organic matter (FYM) @ 3 tonnes/ha and observe the following at 40 days intervals : (i) Number of tillers/m ² , (ii) Height of the plant (cm) (5 plants) and (iii) Leaf rolling at the tip of leaves (scale 1-10) | 83 |
| Lesson 37. | Application of well-decomposed organic manure @ 2 tonnes/ ha, to rice crop transplantation | 85 |
| Lesson 38. | Application of urea fertilizer @ 50 kg N/ha to wheat crop as top-dressing and irrigate the field | 86 |
| Lesson 39. | Recording observations on average basis of (a) height (cm), (b) tiller/m ² of that wheat crop, where wheat was grown in lesson 37 and 38, 3 weeks after application of organic manures and fertilizers and compare them with comments. | 87 |
| Lesson 40. | Checking of soil - erosion by different methods | 89 |

| | | |
|--------------------|--|-----|
| Lesson 41. | Rectification of soil degradation by different ways | 90 |
| Lesson 42. | Correction of soil sickness by different legume crops | 90 |
| Lesson 43. | Practising ploughing with mouldboard plough, in wheat sowing | 95 |
| Lesson 44. | Using the ladder/plank with mouldboard plough, for bringing good tilth in soils, for wheat sowing | 96 |
| Lesson 45. | Draw the parts and label them of mouldboard plough and give the full description of the parts | 100 |
| Lesson 46. | Draw the parts of seed drill (jute) with labellings and describe the parts therein | 100 |
| Lesson 47. | Operate the seed-drill, for jute sowing | 100 |
| Lesson 48. | Practise 'minimal tillage' in wheat after transplanted <i>kharif</i> rice | 102 |
| Lesson 49. | Practise sowing of rainfed <i>paira / utera</i> crops, after transplanted <i>kharif</i> rice | 103 |
| Lesson 50. | Practise 'skip-off' tillage in the rainfed 3-crop system (Jute- transplanted <i>kharif</i> rice- <i>paira/utera</i> crop (no tillage in rainfed <i>paira/utera</i> crop i.e. skip-off tillage) | 104 |
| Lesson 51. | Practise 'puddling' operation for <i>kharif</i> rice transplantation | 106 |
| Lesson 52. | Practise 'earthening-up' in maize crop. | 107 |
| Lesson 53. | Collection and observation of 'setts' of sugarcane for planting | 111 |
| Lesson 54. | Collection and observation of 'tubers' of potato for planting | 112 |
| Lesson 55. | Collection and observation of 'stem-cuttings' of sweet potato and paragrass for planting | 112 |
| Lesson 56. | Collection and observation of banana 'propagules' for planting | 114 |
| Lesson 57. | Collection and observation of 'corm' of ol (<i>amorphophallus</i>) for planting | 115 |
| Lesson 58. | Sowing of wheat in <i>rabi</i> season | 118 |
| Lesson 59. | Sowing of (a) direct-seeded rice (<i>aus</i>) and (b) jute in pre- <i>kharif</i> season, under rainfed conditions | 119 |
| Lesson 60. | Planting of sugarcane in autumn (i.e. before winter) | 121 |
| Lesson 61. | Planting of potato in winter | 122 |
| Lessons 62. | Transplanting of <i>kharif</i> rice | 123 |
| Lessons 63 and 64 | Sow wheat with 50 kg and 100 kg seed rate per hectare in two plots and observe the tiller number/sqm at 45 days after sowing and compare the population between two plots | 125 |
| Lessons 65 and 66. | Apply NPK-fertilizers @ 100 kg N/ha, 50 kg P ₂ O ₅ and 50 kg K ₂ O/ha in wheat, (using ½ N and full of P ₂ O ₅ and K ₂ O at sowing, as basal and rest ½ N use as top-dressing just before first irrigation at CRI stage (i.e. 21 DAS) and in another plot with no fertilizer. At about 45 days after sowing wheat, take the observations, on tillers/sq m, in both the plots and compare the population (i.e. tillers/sqm) to see whether there is increase/decrease in wheat population with comments | 126 |
| Lesson 67. | Take the records of special purpose crops, grown in the <i>rabi</i> season | 139 |
| Lesson 68. | Take the observations on some special-purpose crops, grown in pre- <i>kharif</i> season | 141 |
| Lesson 69. | Recording observations of the special purpose crops, grown in <i>kharif</i> season | 141 |
| Lesson 70. | Preparation of compost in pit/trench | 146 |
| Lesson 71. | Application of the bulky organic manures (obtained from lesson 70) in transplanted rice crop | 147 |

| | | |
|------------|---|-----|
| Lesson 72. | Cultivate <i>dhaincha</i> crop for G.M. and plough-under it, for the <i>kharif</i> transplanted rice. | 148 |
| Lesson 73. | Apply 50 kg N, 50 kg P ₂ O ₅ and 50 kg K ₂ O/ha, as 'basal' dose at wheat sowing | 152 |
| Lesson 74. | Apply 50kg N/ha from urea, as 'top-dressing' in wheat just before first irrigation at CRI (crown root initiation) stage | 153 |
| Lesson 75. | Calculate the amount of fertilizer to be required for fertilizing one hectare of land, with urea @ 100 kg N/ha in wheat | 155 |
| Lesson 76. | Calculate the amount of fertilizer to be needed for fertilizing pulse crops, for one hectare of land, with single superphosphate @ 60 kg P ₂ O ₅ /ha | 156 |
| Lesson 77. | Calculate the amount of muriate of potash to be required, for fertilizing potato crop in one hectare of land, with 60 kg K ₂ O/ha | 157 |
| Lesson 78. | Irrigate the wheat crop, specifying the time for irrigation, by observing the physiological stages | 163 |
| Lesson 79. | Irrigate the sugarcane crop at different stages, by climatological and 'leaf-rolling' approach. | 165 |
| Lesson 80. | Practise the flash-irrigation in potato, before emergence of seedlings | 168 |
| Lesson 81. | Practise for spot-irrigation in chilly crop in the field (after transplantation of seedlings) | 169 |
| Lesson 82. | Prepare the irrigation schedule for wheat and practise on them at all stages | 172 |
| Lesson 83. | Prepare the irrigation schedule for potato and practise them at later stage of the growth (i.e. channel irrigation) | 173 |
| Lesson 84. | Identify with scientific names at least 3 broad-leaved and 3 narrow-leaved weeds in wheat field | 176 |
| Lesson 85. | Identify at least 3 broad-leaved and 3 narrow-leaved weeds with scientific names, of <i>aus</i> rice (direct-seeded) field | 177 |
| Lesson 86. | Identify, with scientific names, at least 3 broad-leaved and 3 narrow-leaved weeds of jute | 178 |
| Lesson 87. | Identify, with scientific names, at least 3 broad-leaved and 3 narrow-leaved weeds of rainfed <i>rabi paira/utera</i> crops (mainly in grasspea field). Describe the beneficial aspect of weeds in <i>rabi</i> rainfed <i>paira/utera</i> crops | 178 |
| Lesson 88. | Calculate the amount of 2,4-D sodium salt, required for spraying one hectare of land, under wheat @ 0.5 kg a.i./ha, 28 days after sowing (DAS) | 180 |
| Lesson 89. | Practise spraying cautiously the same amount of herbicides (as in lesson 88), with 600 litres of water in wheat field | 180 |
| Lesson 90. | Calculate the amount of herbicides for one hector of land from the following: (a) <i>Butachlor</i> @ 1.5 kg a.i./ha in rice, (b) <i>2,4-D</i> @ 0.5 kg a.i./ha in wheat and (c) <i>Fluchloralin</i> @ 0.6 kg a.i./ha in jute, under 'rice-wheat-jute' cropping system, along with required amount of water [@ 500 lit. of water/ha] | 180 |
| Lesson 91. | Spray cautiously, the above mentioned amounts (as in lesson 90) in the said cropping system, using 600 litres of water/ha, at 6 DAT (days after transp- lantation of rice), 28 DAS (days after sowing) in wheat and 3 DAS in jute | 181 |
| Lesson 92. | Run the hoe or wheel-hoe or tine, before first irrigation of wheat but after applying nitrogen for top-dressing in wheat and observe the weed conditions at 30 days after irrigation | 183 |

- Lesson 93. Practise sowing of rainfed *paira/utera* crop of sunnhemp (for seed) in *rabi* and observe the weed-population-condition at 30, 45, 60 days after sowing 184
- Lesson 94. After hand weeding in *aus* rice, use “*shyamaghash* (weed) as fodder. Give it to the cattle and observe their consumption processes and palatability by them (cattle) 187
- Lesson 95. After hand weeding in direct-seeded (*aus*) rice, get “*shyama- ghash*” (weed) and use the weeds (*shyamaghash*) for composting either in pit or in trench and after 6 months, use that compost (organic manure) for multiple cropping system (wheat-jute-rice) 188
- Lesson 96. Sow seeds or clump of plant ‘*lantana*’ or *launea* weeds in the rainy season in the garden for beautiful scent and colour of flowers 189
- Lesson 97. Calculate the amount of rice-straw, to be required for mulching the rainfed wheat in 1000 sq.m area @ 3 tonnes area/ha and procure the same before sowing the rainfed wheat in November 192
- Lesson 98. Spread over the same calculated amount of rice-straw (as in lesson 97) on the soils, immediately after sowing rainfed mustard 193
- Lesson 99. Calculate the production economics in Rs./ha, of rainfed wheat cultivation, from the following data : 194
 (a) Cost of general rainfed wheat cultivation (without mulching) – Rs. 6000/ha, (b) Grain yield of wheat @ 10 q/ha, (c) Straw-yield of wheat @ 18 q/ha, (d) Price of wheat grain Rs. 1400/- per quintal, (e) Price of wheat - straw @ Rs. 100/- per quintal, (f) Cost of mulch materials – @ Rs. 100/- per quintal and (g) Application cost of mulch – @ Rs. 100/hectare.
- Lesson 100. Harvest the top portion of any pulse crop (specifically mungbean) and plough-under the crop-residues 196
- Lesson 101. (a) Harvest the jute crop, (b) Stack them (plants) on the field after bundling them, and (c) Shed the leaves (for utilizing it as manure) and remove the plants (without leaves) and (d) Plough-under leaves before transplantation of *kharif* rice 198
- Lesson 102. Scratch the soils in rice-fallows, with the help of tine/hoe/hoe/ wheel-hoe and observe the moisture conditions, 30 days after scratching the soils. Note down whether moisture is lost or retained, by the visual observation roughly 200
- Lesson 103. Sow rainfed ‘*tetrakalai*’ (giant blackgram)/blackgram in *kharif* season, under rainfed conditions after its harvest for fodder and immediately sow rainfed wheat in November, for proper germination of wheat seeds. Observe visually, whether good soil moisture is there or not, enough for germination of wheat seeds. Count the number of wheat plant/m², 15 days after sowing 201
- Lesson 104. Sow wheat seeds in rainfed rice-fallows, at a depth of 4,8, and 12 cm for observing the germination-position of seeds at 15 days after sowing (DAS) and plant count at 45 DAS 203
- Lesson 105. Sowing rainfed grasspea (*khesari*) as *paira/utera* crops for moisture conservation. Sow rainfed mungbean in pre-*kharif*, immediately after (a) irrigated wheat and (b) for its proper germination. Observe the germination conditions of rainfed mungbean and record the plant numbers at 15 and 45 days after sowing and comment on them. 205
- Lesson 106. Sow barley, lentil, oat, mustard and grasspea in *rabi* season, under rainfed conditions 209
- Lesson 107. Sow greengram, cowpea, sesame, sunflower and sunhemp (for fibre), rice-bean (for fodder), mesta (for fibre) and thinnapier (fodder) in 4 lines, in pre-*kharif* season under rainfed conditions 210

| | |
|---|-----|
| Lesson 108. Sow napiergrass, cowpea, rice-bean, mesta <i>jowar</i> , <i>bajra</i> , blackgram, sunnhemp (for seed), maize for seed (only in eastern India), under rainfed condition in <i>khraif</i> season, in each small plot. | 211 |
| Lesson 109. Recording observations for the changes in growth at stages in <i>rabi</i> season crops (Oat, mustard, wheat, potato and lentil) at 45 days after sowing in <i>rabi</i> season | 222 |
| Lesson 110. Recording observations, on the same sample (as in lesson 109) crops at 60 days after sowing | 223 |
| Lesson 111. Recording observations, on the same <i>rabi</i> samples (as in lesson 109) at 90 days after sowing | 224 |
| Lesson 112. Recording observations, on the same sample at harvest (as in lesson 109) | 224 |
| Lesson 113. Recording observations, on changes of growth of the crops at stages, (<i>Jute</i> , <i>aus</i> rice, mungbean, sesame, maize) in pre- <i>khariif</i> season, at 45 days after sowing | 235 |
| Lesson 114. Recording observations, on changes of growth of the same (as in lesson 113) sample of crops at 60 days after sowing | 236 |
| Lesson 115. Recording observations, on changes of growth of the same (as in lesson 113) crops in pre- <i>khariif</i> season, at 90 days after sowing | 236 |
| Lesson 116. Recording observations, on changes of growth of the same (as in lesson 113) sample of crops in pre- <i>khariif</i> season, at harvest | 237 |
| Lesson 117. Recording observations, on changes of growth of crops [Sunflower, groundnut, jatropha, sesame, ricebean, mungbean, jute (for seed) maize, rice and cowpea] at 45 days after sowing, in <i>khariif</i> season | 248 |
| Lesson 118. Recording observations on changes of growth characters of the same <i>khariif</i> crops (as in lesson 117), at 60 days after sowing | 250 |
| Lesson 119. Recording observations on changes of growth of the same crops (as in lesson 117) at 90 days after sowing, in <i>khariif</i> season | 251 |
| Lesson 120. Recording observations on changes of growth of <i>khariif</i> crops, the same samples (as in lesson 117), at harvest | 252 |
| Lesson 121. Prepare the rainfed cropping system for (i) High rainfall areas, (ii) Coastal areas, and (iii) Semi-dry areas of the country | 255 |
| Lesson 122. Prepare the special rainfed 3-crop system, with <i>paira/utera</i> crops, based on eastern region (i.e. W. Bengal), describing the conditions required for <i>paira utera</i> crops | 256 |
| Lesson 123. Prepare the irrigated cropping systems in different ecosystems in India, describing the weather conditions therein. | 259 |
| Lesson 124. Prepare the ecologically combined (irrigated and rainfed) 3-crop systems in eastern part of the country | 261 |
| Lesson 125. What should be the harvesting criteria of (a) wheat, (b) <i>boro</i> paddy, (c) potato and (d) mustard in <i>rabi</i> season; (i) <i>aus</i> rice, (ii) mungbean, and (iii) jute in pre- <i>khariif</i> season and (A) sugarcane, (B) maize and (C) <i>aman rice</i> in <i>khariif</i> season? Write them in details. | 267 |
| Lesson 126. Practise in details harvesting of wheat after describing the procedure. | 267 |
| Lesson 127. Practise harvesting of <i>boro</i> paddy, after describing the procedure. | 268 |
| Lesson 128. Practise harvesting of potato, after describing the procedure. | 269 |
| Lesson 129. Practise harvesting of mustard, after describing the procedure. | 270 |

| | |
|--|-----|
| Lesson 130. Practise harvesting of <i>aus</i> (direct seeded) rice, after describing the procedure. | 271 |
| Lesson 131. Practise harvesting of mungbean, after describing the procedure. | 272 |
| Lesson 132. Practise harvesting of jute, after describing the procedure. | 273 |
| Lesson 133. Practise harvesting of sugarcane, after describing the procedure. | 274 |
| Lesson 134. Practise harvesting of maize, after describing the procedure. | 275 |
| Lesson 135. Practise harvesting of <i>aman</i> (transplanted <i>khariif</i>) rice, after describing the procedure. | 276 |
| Lesson 136. Give a full picture of symptoms of harvesting of (a) wheat (b) <i>boro</i> paddy, (c) potato and (d) mustard, (e) mungbean and (j) jute | 277 |
| Lesson 137. Describe the symptoms of harvesting of (i) mesta, (ii) grasspea, (iii) ricebean and (iv) jute (for seed) | 278 |
| Lesson 138. Describe the symptoms of harvesting of (A) maize, (B) sugarcane and (C) <i>aman</i> (<i>khariif</i>) rie | 279 |
| Lesson 139. Describe the harvesting criteria of (i) napier, (ii) berseem (c) lucern, and (d) blackgram for fodder. | 280 |
| Lesson 140. Write the procedures of 'processing' for getting the final yields of cereal crops such as, wheat, rice maize, <i>bajra</i> , oat, barley and <i>jowar</i> | 284 |
| Lesson 141. Participation in the grain processing of wheat and <i>khariif</i> rice in farms. | 285 |
| Lesson 142. Describe the procedures for processing in getting the final yields of pulse crops such as greengram, blackgram, lentil, pea, gram, grasspea and redgram (<i>arahar</i>). | 285 |
| Lesson 143. Practise the grain processing of blackgram and <i>arahar</i> (red gram) in farms, describing the procedures of processing. | 286 |
| Lesson 144. Describe, in short, the procedures for getting the final yields of oilseed crops like mustard, sunflower, groundnut, sesame and safflower and jatropha. | 286 |
| Lesson 145. Practise the processing for getting seeds of mustard and sesame in the farms. | 287 |
| Lesson 146. Write, in short, the procedures for getting final yields of fibre crops of jute, mesta, sunnhemp, flax and cotton. | 287 |
| Lesson 147. Practise in the processing for getting fibre yield of jute and mesta in the farms. | 287 |
| Lesson 148. Describe the procedures, for getting the final yields of sugars from sugarcane | 288 |
| Lesson 149. Participate in the ' <i>gur</i> 'sugar manufacturing unit to know the processing in details, for obtaining the final produce. | 288 |
| Lesson 150. Describe the procedures for getting the final yields of potato. | 288 |
| Lesson 151. Practise for (a) processing and (b) storage of potato in the cold storage. | 289 |
| Lesson 152. Describe the procedures for processing of legume fodders of berseem, lucern, blackgram, rice-bean and grasspea. | 289 |
| Lesson 153. Participate in the 'cutting-process' and harvesting of berseem lucern, black-gram, ricebean and grasspea in the dairy areas. | 290 |
| Lesson 154. Describe the procedures for processing of non-legume fodder crops of napier, teosinte and mustard-fodder. | 290 |
| Lesson 155. Participate in harvesting process of napier and thin napier in the farms or in dairy areas. | 291 |

| | | |
|----------------------|---|-----|
| Lessons 156 and 157. | Visit the godown, cold storage, and silage pits, for observing the storage of produce of (i) cereals, (ii) pulses, (iii) oilseeds, (iv) sugars, and (v) fibres and (vi) tubers (potato) and take the visual observations/ records. | 293 |
| Lesson 158. | Visit the 'dairy farm', for looking into the feeding techniques of fodders, along with the home system and also visit 'silopit' areas in the same dairy farm and record the procedures for 'silage' preparation. | 293 |
| Lessons 159 to 168 | The B.Sc. (Ag.) Hons. students should be allotted individual plots, for the management of crops. The plots should be distributed to all the students in B.Sc. (Ag) class, with specific crop. to each of them, in different seasons (the class teacher will look into the work). The rough distribution of practical classes for student-plots are as follows : | 304 |

Management of individual-plot with specific crop, allotted to each student. under irrigated condition, in lessons 159 to 168

Break-up of the lessons for individual plot :

| | | |
|-------------|---|-----|
| Lesson 159. | Arrangement of inputs like seeds, manures, fertilizers, tillage implements, irrigation appliances etc. | 304 |
| Lesson 160. | Tillage operations for the specific crop cultivation | 305 |
| Lesson 161. | Sowing of specific crop, with variety, seed rate etc. | 305 |
| Lesson 162. | Fertilization in crop : (a) basal and (b) top dressing in crop | 305 |
| Lesson 163. | Irrigation in specific crop | 305 |
| Lesson 164. | Weeds and weed management in crop (like weeding etc.) | 305 |
| Lesson 165. | Intercultural operations (like hoeing/stirring/earthening-up etc. – in specific crop) | 305 |
| Lesson 166. | Harvesting and processing of specific crop | 305 |
| Lesson 167. | Recording all sorts of data regarding all operations for crop cultivation in 'individual plot' | 305 |
| Lesson 168. | Production economics of crop/crops | 305 |
| Lesson 169. | Calculate the net income from the following data (Rs./ha) : | 305 |
| | (a) Cost of cultivation of 'A' crop – Rs. 12,000/- (b) Grain and straw yields – 20 and 30 quintals per hectare respectively, and (c) Price of grain and straw – Rs.1200/- and Rs. 100/- per quintal respectively. | |
| Lesson 170. | Calculate the net income of crops from one hectare of land (Rs./ha), under irrigated conditions, in '3-crop system' (with crops A, B and C), from the following data : | 305 |
| Crop A : | (i) Cost of cultivation – Rs. 20,000/- per hectare, (ii) Produce and by-product – 250 and 700 quintals/ha respectively, and (iii) Selling price of product and by-product – Rs. 500/- and Rs. 50/- per quintal respectively | 305 |
| Crop B : | (i) Cost of cultivation – Rs. 8,000/- per hectare, (ii) Main produce and by-product – 22 and 35 quintals/ha respectively, and (iii) Selling price of main produce and by-product – Rs. 1200/- and Rs. 100/- per quintal respectively, and | 306 |
| Crop C : | i) Cost of cultivation Rs. 7,000/- per ha., ii) Main produce and by-product – 22 and 30 quintals/ha respectively and iii) Selling price of main produce and by-product – Rs. 1200/- and Rs. 100/- per quintal respectively. | 306 |

CONTENTS

Preface

v

List of Lessons under Practical Classes (Lessons 1 to 170)

vii

| | | |
|-----------|---|---------------|
| 1 | INTRODUCTION | 1-7 |
| 1.1 | Agriculture and Agronomy | 1 |
| 1.2 | Practical approach for solving the problem | 4 |
| 1.3 | Development of Agriculture in the country | 6 |
| 2. | PRELIMINARY KNOWLEDGE FOR AGRONOMY STUDIES | 8-59 |
| 2.1 | Basic knowledge about the lands, soils, farmers' field, college or university farms and ICAR Research Institute farms | 8 |
| 2.2 | Identification of common seeds of the field crops | 11 |
| 2.3 | Identification of manures and fertilizers | 17 |
| 2.4 | Identification of common field crops | 26 |
| 2.5 | Knowledge about some farm implements | 33 |
| 2.6 | Identification of weeds and other enemies of crops | 49 |
| 3 | CLIMATE AND ITS INFLUENCE ON CROP PRODUCTION | 60-75 |
| 3.1 | Climate | 60 |
| 3.2 | Influence of weather on crops | 66 |
| 3.3 | Influence of weather on weeds | 72 |
| 4 | SOIL ENVIRONMENT AND ITS MODIFICATION FOR CROP PRODUCTION | 76-91 |
| 4.1 | Soil environments | 76 |
| 4.2 | Modification of soil environments | 84 |
| 4.3 | Soil conservation | 87 |
| 5. | TILLAGE AND CROP PRODUCTION | 92-108 |
| 5.1 | Types of tillage | 92 |
| 5.2 | Good tilth | 93 |
| 5.3 | Objective of tillage | 94 |
| 5.4 | Tillage implements | 98 |

| | | |
|------------|---|----------------|
| 5.5 | Modern concept of tillage | 101 |
| 5.6 | Special tillage | 105 |
| 6 | SEEDS, SOWING, STAND ESTABLISHMENT AND CROP CLASSIFICATION | 109-143 |
| 6.1 | Seeds (Botanical and agronomic view points) | 109 |
| 6.2 | Sowing | 116 |
| 6.3 | Stand establishment | 124 |
| 6.4 | Classification of crops | 128 |
| 6.5 | Special purpose crops | 130 |
| 7 | MANURES AND FERTILIZERS FOR CROP PRODUCTION | 144-159 |
| 7.1 | Mineral nutrition for the crops/plant | 143 |
| 7.2 | Importance of organic manures | 144 |
| 7.3 | Fertilizers | 150 |
| 7.4 | Integrated nutrient management | 158 |
| 8 | IRRIGATION FOR CROPS AND CROPPING SYSTEMS | 160-173 |
| 8.1 | Water requirement of crops in stages | 160 |
| 8.2 | Scheduling of irrigation in crops, based on | 162 |
| 8.3 | Method of irrigation | 167 |
| 8.4 | Irrigation schedule for crops | 171 |
| 9. | WEEDS AND WEED MANAGEMENT FOR CROP PRODUCTION | 174-190 |
| 9.1 | Weeds | 174 |
| 9.2 | Weed control in crops/cropping systems by herbicides | 179 |
| 9.3 | Cultural management for weeds and partial control/checking of weeds | 182 |
| 9.4 | Utilization of weeds in different forms | 185 |
| 10. | SOIL MOISTURE MANAGEMENT UNDER RAINFED CONDITIONS | 191-211 |
| 10.1 | Mulching | 191 |
| 10.2 | Crop-residue management with | 195 |
| 10.3 | Soil and crop / cropping manipulation | 199 |
| 10.4 | Agronomic manipulation | 202 |
| 10.5 | Crops for rainfed systems | 207 |
| 11. | MAJOR CROPS CULTIVATION (in short) | 212-252 |
| 11.1 | <i>Rabi</i> season | 212 |
| 11.2 | <i>Pre-kharif</i> season | 225 |
| 11.3 | <i>Kharif</i> season | 237 |

| | |
|--|----------------|
| 12. CROPPING SYSTEM | 253-262 |
| 12.1 Under raifned conditions, with | 253 |
| 12.2 Under irrigated conditions | 257 |
| 12.3 Partially rainfed & partially irrigated conditions (in eastern part of India) | 260 |
| 13. HARVESTING OF CROPS, CROP-YIELDS AND THEIR STORAGE | 263-293 |
| 13.1 Harvesting of different crops | 263 |
| 13.2 Crop yields (produce) and processing | 280 |
| 13.3 Storing of seeds, fibres, straw and by-products | 291 |
| 14. VITAL INFORMATION FOR PRACTICAL APPROACH | 294-318 |
| 14.1 Classified crops in seasons (with scientific names, English and local names, along with different families) | 294 |
| 14.2 Soil analytical data of the farm and moisture status in 'rice-fallows' in dry months | 300 |
| 14.3 Data on rainy/cloudy days and bright sunshine hours, all the year round at BCKV (W.B.) | 302 |
| 14.4 Production economics of crops | 303 |
| 14.5 Soil fertility ranking/grading | 306 |
| 14.6 Requirement of NPK-fertilizers for unit area of crop production | 307 |
| 14.7 Yield estimation of some crops | 308 |
| 14.8 No-tillage relay (<i>paira/utera</i>) crops under rainfed conditions in different seasons | 311 |
| 14.9 Climatological data and rainfed crops therein | 312 |
| 14.10 Preparation of herbarium on | 314 |
| 14.11 Provision of glass-jars for | 315 |
| 14.12 Meterological observatory equipments (Ordinary observatory) | 316 |
| 14.13 Visit to different farms for different purposes (Farms of ICAR Research Institute, Farmers field, Govt. Farms & University Farms | 316 |
| 14.14 Allotment of individual plots to the students | 317 |
| 14.15 Production economics for crops, grown in individual pilot | 318 |
| LIST OF SKETCHES OF | 319-334 |
| (A) Tillage Implements, (B) Crops, (C) Weeds and (D) Others | |
| I : Ability and disability of guiding fertilizer mixtures | 320 |
| II : Morphological characteristics of some main crops | 321 |
| III : List of Sketches of (A) Tillage Implements, (B) Crops, (C) Weeds and (D) Others | 322 |
| REFERENCES | 335-336 |

