ISSN: 0021-8596

THE JOURNAL OF AGRICULTURAL SCIENCE



journals.cambridge.org/ags



tps://doi.org/10.1017/S0021859612000482 Published online by Cambridge University Press

The Journal of Agricultural Science

SENIOR EDITORS

Prof. R. E. L. Naylor University of Aberdeen, Room G17, 23 St. Machar Drive, Aberdeen AB24 3RY, UK

Prof. J. Wiseman University of Nottingham, School of Biosciences, Sutton Bonington Campus, Loughborough, Leicestershire LE12 5RD, UK

EDITORIAL BOARD

T. Aveling, University of Pretoria, South Africa
P. Bilsborrow, Newcastle University, UK
S. C. Bishop, Roslin Institute, Edinburgh, UK
M. D. Casler, US Dairy Forage Research Center, Madison, USA
S. Ceccarelli, ICARDA, France
A. Cobb, Sedbergh, UK
B. R. Cullis, University of Wollongong, Australia
J. Dijkstra, Wageningen University, The Netherlands
R. N. Edmondson, Warwick HRI, Wellesbourne, UK

SUBMISSIONS

The Journal has moved to electronic submission. Manuscripts should be uploaded to http://mc.manuscriptcentral.com/jagric-sci. Double-blind refereeing has also been adopted, therefore the authors' names, addresses and emails should be removed from the main document and uploaded as a title page in a separate file, tagged 'Not for Review'. Help is available on the website.

SUBSCRIPTIONS

The Journal of Agricultural Science (ISSN 0021-8596) is published six times a year in February, April, June, August, October and December. Six parts form a volume. The subscription price (excluding VAT) of Volume 150 (2012) (which includes delivery by air where appropriate, plus electronic access to institutional subscribers) is £820 net (US \$1450.00 in the USA, Canada and Mexico). Single parts are £135 net (US \$239 in the USA, Canada and Mexico. The electronic only price available to institutional subscribers is £645.00 (\$1140.00 in USA, Canada and Mexico). Back issues are also available.

Orders, which must be accompanied by payment, may be sent to a bookseller, subscription agent or direct to the publisher: Cambridge University Press, The Edinburgh Building, Shaftesbury Road, Cambridge CB2 8RU, UK; or in the USA, Canada and Mexico: Cambridge University Press, Journals Fulfillment Department, 100 Brook Hill Drive, West Nyack, New York 10994–2133. EU subscribers (outside the UK) who are not registered for VAT should add VAT at their country's rate. VAT registered subscribers should provide their VAT registration number. Japanese prices for Institutions are available from Kinokuniya Company Ltd, PO Box 55, Chitose, Tokyo 156, Japan.

POSTMASTER: send address changes in the USA, Canada and Mexico to: The Journal of Agricultural Science, Cambridge University Press, 100 Brook Hill Drive, West Nyack, New York 10994–2133. Claims for missing issues should be made immediately on receipt of the subsequent issue. J. Eitzinger, University of Natural Resources and Applied Life Sciences (BOKU), Vienna

- W. Erskine, CLIMA, University of Western Australia, Australia
- J. France, University of Guelph, Canada
- G. Hoogenboom, Washington State University, USA
- M. O. Humphreys, Institute of Grassland and Environmental Research, Aberystwyth, UK
- R. Hunter, CSIRO, Livestock Industries, Division of Tropical Production, Queensland, Australia
- P. S. Kettlewell, Harper Adams University College, UK
- J. Lauren, Cornell University, Ithaca, NY USA
- S. J. Mooney, University of Nottingham, UK
- S. Orlandini, University of Florence, Italy
- C. K. Reynolds, University of Reading, UK
- J. A. Rooke, SAC, Edinburgh, UK
- U. R. Sangakkara, University of Peradeniya, Sri Lanka
- N. St. Pierre, Ohio State University, USA
- C. Watson, Scottish Agricultural College, Aberdeen, UK

COPYING

No contents may be reproduced by any means without the permission of Cambridge University Press. This journal is registered with the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923, USA (www.copyright.com). Organizations in the USA who are also registered with the CCC may therefore copy material (beyond the limits permitted by sections 107 and 108 of US copyright law) subject to payment to CCC. This consent does not extend to multiple copying for promotional or commercial purposes. ISI Tear Sheet Service, 3501 Market Street, Philadelphia, PA 19106, USA, is authorized to supply single copies of separate articles for private use only. Organizations authorized by the Copyright Licensing Agency may also copy material subject to the usual conditions. For all other use, permission should be sought from Cambridge or the American Branch of Cambridge University Press.

INTERNET ACCESS

This journal is included in the Cambridge Journals Online service which can be found at http://www.journals.cambridge.org For further information on other Press titles access www.cambridge.org

This journal issue has been printed on FSC-certified paper and cover board. FSC is an independent, non-governmental, not-for-profit organization established to promote the responsible management of the world's forests. Please see www.fsc.org for information.

CAMBRIDGE UNIVERSITY PRESS

The Edinburgh Building, Shaftesbury Road, Cambridge CB2 8RU, United Kingdom

32 Avenue of the Americas, New York, NY 10013–2473, USA 477 Williamstown Road, Port Melbourne, VIC 3207, Australia Ruiz de Alarcón 13, 28014 Madrid, Spain

Dock House, The Waterfront, Cape Town 8001, South Africa

Printed in the United Kingdom by the University Press, Cambridge

© Cambridge University Press 2012