REPORT ON THE ACTIVITIES OF THE EXPERT TEAM 4.1 (CAPACITY BUILDING) OF FOCUS AREA 4 (CAPACITY DEVELOPMENT IN AGRICULTURAL METEOROLOGY) OF THE COMMISSION FOR AGRICULTURAL METEOROLOGY (CAgM): 2014-2018.

1.0 Introduction: The main objective of Focus Area 4 (Capacity Development in Agricultural Meteorology) is to enhance the capacity of member-countries of WMO in the provision of Agro-meteorological Information Services (AIS) through increased access to modern and more efficient agro-meteorological related knowledge and training tools. In order to achieve this, the functions of FA4 were undertaken by its two Expert Teams (ETs) namely:

(a) ET4.1 - Capacity Building and
(b) ET4.2 - Education and Training

and associated Task Teams (TTs), i.e.

TT4.1 on "Developing Online Community of Climate and Agricultural Production" and
TT4.2 on "Identifying Agmet Publications and the Guide to Agricultural Practices (GAMP)".

Elena Mateescu (Romania) RA VI was the Chair of the Focus Area, while Julie Ukeje (Nigeria) RA I was the Co-Chair. Their key mandate is to carry out overall coordination and monitoring of activities of the two ETs and their TTs, as well as communicate progress reports to the Management Group (MG) of the CAgM.

MS Ujeke later doubled as the "Acting" Team Leader of ET4.1 following the passing away the assigned Leader: Barnabas Chipindu (ZIMBABWE) – RA I half way into the CAgM-16 session.

This report therefore focuses only on the activities of ET 4.1. Details of the memberships of ET4.1and its Task Team (TT4.1) are as stated below:

ET 4.1 - Capacity Building

(i) James Adamu (NIGERIA) – RA I;
(ii) K.K. Singh (INDIA) – RA II;
(iii) Maria Elena Fernandez-Long (ARGENTINA) – RA III;
(iv) Manasah Mkhabela (CANADA) – RA IV;
(v) Christa Pudmensky (AUSTRALIA) – RA V; and
(vi) Josep Eitzinger (AUSTRIA) – RA VI**.**

There were no inputs/submissions from ET4.1's members covering RA II and RA VI. ET4.1's tasks consist of the following 5 Terms of Reference (TORs):

Terms of Reference for ET 4.1

1. **TOR 1:** Review and report on the potential synergies between WMO training programmes (e.g. crop modelling, GIS and remote sensing applications in agro-meteorology, climate smart agriculture, water footprint etc.) and other international training programmes in order to identify needs/constraints/opportunities of trainees to understand and use dedicated services and products;

2. **TOR 2:** Identify training needs required to improve agricultural meteorological services that meet user requirements;
3. **TOR 3:** Review existing agro-meteorological training activities (i.e. modules, exercises, distance learning, seminars) and recommend which activities should be further used in agro-meteorological training in your country;
4. **TOR 4:** Review the agro-meteorological training opportunities and methodologies from funded projects and in collaboration with the Global and National Agro-meteorological Societies; and
5. **TOR 5:** Review the WMO Global Campus Initiative and make recommendations how to integrate the work of the GCREAMS with this initiative.

Subsequent sections of this write-up comprise summaries of inputs received from the **four RAs (i.e. RAs I, III, IV and V**); (copies attached), along with recommendations for each of the 5 TORs. Methodology employed include email correspondences to PRs, fellow members of the Teams and relevant institutions and universities.

2.0 Activities Carried Out Under TOR 1: Review and report on the potential synergies between WMO training programmes (e.g. crop modelling, GIS and remote sensing applications in agro-meteorology, climate smart agriculture, water footprint etc.) and other international training programmes in order to identify needs/constraints/opportunities of trainees to understand and use dedicated services and products.

All the four regions reported existence of potential synergies between WMO training programmes and other international training programmes after carrying out the required reviews. However, not many of the courses/training programmes arising from such synergies are directly agro-meteorological-related. The following are some international institutions that have agro-met related synergies along with focus training areas/opportunities and links as reported by the respective RAs:

2.1 RA I's Identified International Institutions that have Synergies with WMO's Agro-meteorological Training Programmes & Resulting Training Opportunities:

(i) Southern African Development Community (SADC) in Mauritius in the areas of crop modelling, remote sensing, use of seasonal forecast by farmers and climate change impacts in agriculture and

(ii) Development of Decision Support System for Agro-technology Transfer (DSSAT along with its crop simulation models have been used for many applications ranging from on-farm and precision management to regional assessments of the impact of climate variability and climate change

Training opportunities emerging from the synergies, along with recommendations are:

(i) Inclusion of satellite rainfall estimate such as RFE and CHIRPS (Climate Hazard Group Infrared Precipitation with Station data) in agro-met training programmes.
(j) Improvement of CHIRPS using GeoCLIM and more station data normally available at the country level; and

Recommendations: The DSSAT and SADC trainings will be of great assistance for the region, especially in addressing challenges impact of extreme weather on crops. Closer collaborations

between NMHSs and their respective governments and agro-allied organizations are also highly recommended, especially for Mauritius' Meteorological Service, where this was lacking.

2.2 RA III's Identified International Institutions that have Synergies with WMO's Agro-meteorological Training Programmes & Resulting Training Opportunities:

(i) The Inter-American Institute for Cooperation on Agriculture (IICA) http://www.iica.int/es);
(ii) The Research Program on Climate Change, Agriculture and Food Security (CCAFS), httpAS s://ccafs.cgiar.org/);
(iii) The Project CRN-3035 "Towards Usable Climate Science - Informing Sustainable Decisions and Provision of Climate Services to the Agriculture and Water Sectors of Southeastern South America" (http://serviciosclimaticos.blogspot.com.ar/);
(iv) Center for Research on Sustainable Agricultural Production Systems (CIPAV) http://www.cipav.org.co/;
(v) The Foundation for the Promotion and Research of Andean Products (PROINPA), http://www.proinpa.org); and
(vi) The National Institute of Agricultural Technology Institutions (from Argentina, (INTA), https://inta.gob.ar/; Uruguay, (INIA); http://www.inia.uy; Chile, (INIA), http://www.inia.cl, etc.)

Details of all trainings opportunities identified in the region, including agro-meteorological related ones and access-links are provided in table 1.

Table 1. Report of training activities RA III

Country	Course Title	Institution	Activities from funded projects	Recommend activities	Place	Length of Course	Course link
International	Gestión del riesgo agroclimático en América Latina	**FAO** (Food and Agriculture Organization)	X	X	Virtual	35 hs	http://bit.ly/1z2CIri
International	Climate change in Latin America	**IAI** (Inter-American Institute for Global Change Research)	X	X	Virtual		http://www.cclatam.org/
International	São Paulo School of Advanced Science on nitrogen cycling, environmental sustainability and climate change	**IAI** (Inter-American Institute for Global Change Research)	X	X	Universidad de São Paulo (USP)	40 hs	http://bit.ly/2BSrGS4
International	Comprendiendo el cambio y la variabilidad del clima en las Américas	**IAI** (Inter-American Institute for Global Change Research)	X	X	INPE/CPTEC Brasil		http://bit.ly/2EMN6lw
International	AGRIMONITOR: política agropecuaria, seguridad alimentaria y cambio climático	**BID** (Banco Interamericano de Desarrollo)	X		Virtual	40 hs	http://bit.ly/2oaCNNC
International	Biodiversidad en Estudios de Impacto Ambiental (BEIA)	**BID** (Banco Interamericano de Desarrollo)	X		Virtual	50 hs	http://bit.ly/2BvZapg
International	Fundamentos del Cambio Climático	**BID** (Banco Interamericano de Desarrollo)	X		Virtual	10 hs	http://bit.ly/2EGYkYL
International	Cálculo y evaluación de la Huella Hídrica como herramienta para la sostenibilidad territorial y la adaptación al cambio climático.	**IICA** (Instituto Interamericano de Cooperación para la Agricultura)	X	X	Virtual	10 hs	http://bit.ly/2Bz0bNp
International	Fundamentos de la Huella Hídrica en el Sector Agrícola en un Contexto de Cambio Climático	**IICA** (Instituto Interamericano de Cooperación para la Agricultura)	X	X	Virtual	10 hs	http://bit.ly/2sBsjwp
International	MOOC: Introducción al uso y representación de Información Geoespacial	**IICA** (Instituto Interamericano de Cooperación para la Agricultura)	X	X	Virtual	10 hs	http://bit.ly/2o4V5k7
International	Balance Hidrológico	**SMN** (Servicio Meteorológico Nacional Argentino)		X	Virtual	25 hs	http://bit.ly/2Ge9ukL
International	Meteorología en el marco de la Reducción de Riesgo de Desastre: Interacción entre servicios meteorológicos y tomadores de decisión.	**SMN** (Servicio Meteorológico Nacional Argentino)			Virtual	30 hs	http://bit.ly/2HjaHsk
International	Taller de capacitación en controles de calidad de datos climáticos diarios, verificación y corrección manual de datos y cálculo de varios índices de sequía	**CRC-SAS** (Centro Regional del Clima para el Sur de America del Sur)	X	X	Servicio Meteorológico Nacional, Argentina	24 hs	http://bit.ly/2HkJvcO

International	Taller sobre técnicas de homogenización de datos climáticos y uso de índices para el monitoreo de sequias.	**CRC-SAS** (Centro Regional del Clima para el Sur de America del Sur)	X	X	Asunción, Paraguay	35 hs	http://bit.ly/2BuaLVP
Argentina	Introducción a la Teledetección Ambiental	**SMN** (Servicio Meteorológico Nacional Argentino)			SMN, Buenos Aires.	20 hs	http://bit.ly/2GgMG3L
Argentina	Geomagnetismo y relaciones terrestres slares	**SMN** (Servicio Meteorológico Nacional Argentino)			SMN, Buenos Aires.	30 hs	http://bit.ly/2oadN9r
Argentina	Clima y Enfermedades de Cultivo	**INTA** (Instituto Nacional de Tecnología Agropecuaria)		X		3 hs	http://bit.ly/2F679Jc
Argentina	Taller sobre Manejo Sustentable del Suelo y Desertificación	**INTA** (Instituto Nacional de Tecnología Agropecuaria)			EEA, Entre Ríos		http://bit.ly/2ExsqdC
Argentina	Aprovechamiento de agua de lluvia para usos múltiples	**INTA** (Instituto Nacional de Tecnología Agropecuaria)			EEA Sáenz Peña, Chaco, Argentina	6 hs	http://bit.ly/2ocVMae
Argentina	Curso Invernaderos, climatización y riego	**INTA** (Instituto Nacional de Tecnología Agropecuaria)			INTA, Buenos Aires.	40 hs	http://bit.ly/2HloKOf
Argentina	Información climática para la gestión del riesgo en el sector agropecuario	**INTA** (Instituto Nacional de Tecnología Agropecuaria)			EEA Sáenz Peña, CR Chaco - Formosa	16 hs	http://bit.ly/2oaCv9F
Argentina	Modelización del balance hídrico	**FCEyN-FAUBA** (Universidad de Buenos Aires)		X	Facultad de Agronomía, UBA	48 hs	http://bit.ly/2EKeXTj
Argentina	Bioclimatología agrícola y agroclimatología	**FCEyN-FAUBA** (Universidad de Buenos Aires)			Facultad de Agronomía, UBA	96 hs	http://bit.ly/2EKeXTj
Argentina	Modelos de simulación de aplicación agronómica	**FAUBA** (Facultad de Agronomía, Universidad de Buenos Aires)		X	Facultad de Agronomía, UBA		http://bit.ly/2sCyYXg
Argentina	Introducción al Manejo Dinámico de los Paisajes Sudamericanos	**FAUBA** (Facultad de Agronomía, Universidad de Buenos Aires)			Virtual	45 hs	http://bit.ly/2EMlo8i
Argentina	CURSO DE CAPACITACIÓN EN EL USO DE INFOSTAT	**UNaM** (Universidad Nacional de Misiones)			Fac. de Cs. Forestales, UNAM, Misiones	35 hs	http://bit.ly/2C3oHHl
Bolivia	CURSO INTERNACIONAL EN AGROMETEOROLOGIA APLICADA	**FAO** (Food and Agriculture Organization)	X	X	La Paz, Bolivia	112 hs	http://bit.ly/2EIwFGH
Brasil	Treinamento de Software R e Aplicações em Agrometeorologia	USP (Universidade de São Paulo)		X	Escola Superior de Agricultura "Luiz de Queiroz", Universidade de São Paulo	8 hs.	http://bit.ly/2GhX4IC
Brasil	Trabalhando com dados espaciais no QGIS 2.18.4	**Embrapa** (Empresa Brasileira de Pesquisa Agropecuária, Ministério da Agricultura, Pecuária e Abastecimento)		X	Campinas, Sao Paulo, Brasil	16 hs	http://bit.ly/2CoBjV5
Brasil	Curso: Tópicos Especiais em Conservação de Meio Ambiente	**Embrapa** (Empresa Brasileira de Pesquisa Agropecuária, Ministério da Agricultura, Pecuária e Abastecimento)			Rio de Janeiro, Brasil	50 hs	http://bit.ly/2EyqUwh
Brasil	Curso sobre Agrometeorologia	**Embrapa** (Empresa Brasileira de Pesquisa Agropecuária, Ministério da Agricultura,			Instituto Agronômico de Pernambuco (IPA), Recife	8 hs.	http://bit.ly/2HjbTMk

		Pecuária e Abastecimento)				
Brasil	Conhecendo o sistema de monitoramento agrometeorológico Agritempo	**Embrapa** (Empresa Brasileira de Pesquisa Agropecuária, Ministério da Agricultura, Pecuária e Abastecimento)		Campus da Unicamp - Barão Geraldo, Campinas San Pablo		http://bit.ly/2oaeek5
Brasil	Curso Agritempo - Sistema de Monitoramento Agrometeorológico	**Embrapa** (Empresa Brasileira de Pesquisa Agropecuária, Ministério da Agricultura, Pecuária e Abastecimento)		Santo Antônio de Goiás, Goiás, Brasil	7 hs.	http://bit.ly/2sy4CVB
Chile	Seminario internacional cambio climático y la viticultura en Chile y México	**INIA** (Instituto de Investigaciones Agropecuarias)		Santiago, Chile	16 hs	http://bit.ly/2Hm0mMf
Chile	Capacitación en agrometeorología	**INIA** (Instituto de Investigaciones Agropecuarias)		Quilamapu - Chillán, Chile		http://bit.ly/2EKrR3v
Chile	Curso de capacitación en agrometeorología,	**UTALCA** (Universidad de Talca)		Centro de Inv. y Transf. en Riego y Agroclimatología (CITRA), Fac. de Cs. Agr.	16 hs	http://bit.ly/2BAwDP4
Chile	Relación Suelo-Agua-Planta	**UCHILE** (Universidad de Chile)		Lab. de Relación Suelo-Agua-Planta (SAP) de la Fac. de Cs Agr. de la Univ. de Chile		http://bit.ly/2Bx1z2Q
Chile	Fundamentos del Pronóstico Meteorológico por Conjuntos	**DMC** (Dirección Meteorológica de Chile)				http://bit.ly/2EyrYAh
Chile	Teledeteción I,II y III	**CIREN** (Centro de Información de Recursos Naturales)	X			http://bit.ly/2EwYin3
Colombia						
Ecuador	Curso presencial de Sistemas de Información Geográfica aplicados a la gestión del territorio	**IEE** (Instituto Espacial Ecuatoriano)		Universidad Regional Amazónica – IKIAM	40 hs	http://bit.ly/2F7QLYC
Ecuador	Ambiente, Sostenibilidad y Cambio Global	**IKIAM** (Universidad Regional Amazónica)		Universidad Regional Amazónica – IKIAM	40 hs	http://bit.ly/2EH09F5
Ecuador	Taller de capacitación en agrometeorología, orientado al Cambio Climático y la agricultura.	**INAMHI** (Instituto Nacional de Meteorología e Hidrología)		Instituto Espacial Ecuatoriano, Guayaquil, Ecuador	16 hs	http://bit.ly/2o3oCdX
Guyana						
Paraguay	Balance Hidrológico Operativo para el Agro	**IAI** ((Inter-American Institute for Global Change Research, Project CRN-3035)	X	Universidad Nacional de Asunción, Paraguay.	40 hs	http://bit.ly/2C1HP8K
Paraguay	Mapas de Riesgo Agropecuario en Paraguay	**IAI** ((Inter-American Institute for Global Change Research, Project CRN-3035)	X	Asunción, Paraguay, IICA	24 hs	http://bit.ly/2oamEHY

Paraguay	Curso sobre Paquete Estadístico R	**IAI** ((Inter-American Institute for Global Change Research, Project CRN-3035)	X	X	Asunción, Paraguay, IICA		http://bit.ly/2CnMayJ
Paraguay	Curso de agrometeorología y gestión de riesgos	**MAG** (Ministerio de Agricultura y Ganadería)	X		Univ. Católica de Coronel Oviedo, Depto. de Caaguazú, Paraguay		http://bit.ly/2Co2X4I
Perú	CURSO TALLER: "IMPLEMENTACION DE LOS METODOS Y PROTOCOLOS DEL COMPONENTE DE CLIMA DE AgMIP"	**SENAMHI** (Servicio Nacional de Meteorología e Hidrología)			Centro de capacitación de SENAMHI Jesús María, Lima, Perú		http://bit.ly/2ob8vKO
Perú	Cursos de capacitación en: Modelamiento Numérico, Fenómeno El Niño, Climatología y Análisis sinóptico.	**SENAMHI** (Servicio Nacional de Meteorología e Hidrología)					http://bit.ly/2F9LbFq
Perú	Cursos de capacitación sobre las bases físicas del cambio climático.	**SENAMHI** (Servicio Nacional de Meteorología e Hidrología)					http://bit.ly/2F9LbFq
Perú	SUELO AGRICOLA Y LA AGROMETEOROLOGÍA	**DRA** (Dirección Regional Agraria)			Puno, Perú	16 hs	http://bit.ly/2F9LcsY
Surinam							
Uruguay	Curso de Agrometeorología	**Fagro** (Facultad de Agronomía. Universidad de la República.)			Fac. de Agr., Universidad de la República.		http://bit.ly/2F7uRVt
Uruguay	MOSAICC: Sistema de Modelización de Impactos Agrícolas del Cambio Climático	**INUMET** (Instituto Uruguayo de Meteorología)		X	Montevideo	32 hs	http://bit.ly/2GgK85K
Uruguay	Taller sobre el uso del modelo SWAT	**INIA** (Instituto Nacional de Investigación Agropecuaria)			Facultad de Ingeniería, Universidad de la República	40 hs	http://bit.ly/2CpiT6H
Venezuela							

2.3 RA IV's Identified International Institutions that have Synergies with WMO's Agro-meteorological Training Programmes & Resulting Training Opportunities:

(i) The Agricultural Model Inter-comparison Project (AgMIP) in the area of **Crop modelling** to improve the state of agricultural simulation and to understand climate impacts on the agricultural sector at global and regional scales**;** http://www.agmip.org/about/

(ii) The Decision Support System for Agro-technology Transfer (DSSAT) Group: DSSAT

(iii) The Food & Agriculture Organization (FAO) (http://www.fao.org/climate-smart-agriculture/en/) on (1) **Climate Smart Agriculture** and **Crop Modelling,** (2) graduate courses in agro-meteorology, application of remote sensing to agro-meteorology and specific courses on the use of Cropwat v8 (a decision support tool developed by FAO for calculating crop water requirements and irrigation requirements and irrigation scheduling based on soil, climate and crop data), (3) AquaCrop v6 (a crop growth model developed by FAO to simulate crop yield response to water), (4) AquaCrop-GIS (facilitates the use of AquaCrop when a high number of simulations is needed), (5) platform for SEQUIA-ASIS (a tool to help countries monitor agricultural drought and manage its risks, using satellite data to detect cropped land that could be affected by drought. The country-specific version of the tool is based on the general methodological principles of the global Agricultural Stress Index System, ASIS) (http://www.fao.org/3/a-i5246e.pdf).

(iv) The Water Foot Print Network(http://waterfootprint.org/en/about-us/events/e-learning_sept_2015/), the **Polytechnique Montreal** in Canada (http://www.wulca-waterlca.org/index.html) and the **Institute for Water Education** in partnership with **UNESCO (**https://www.un-ihe.org/short-courses) offer courses (including online courses) on the calculation of water foot print and other courses related to water. **Cap-Net UNDP (**an international network for capacity development in sustainable water management; http://www.cap-net.org/) also has training courses in water footprint;

(v) Centro International Para La Investigacion del Fenomeno de El-Nino (CIIFEN), Ecuador on topics related with climate forecasting and drought forecasting;

RA IV also reported the following agro-meteorological trainings at post-graduate level:

(a) In Canada: University of Manitoba, Department of Soil Science (http://umanitoba.ca/faculties/afs/dept/soil_science/research/agrometeorology.html), University of Guelph (https://www.uoguelph.ca/ses/research/earth-and-atmospheric-sciences) and University of British Columbia, Biometeorology and Soil Physics Group http://biomet.landfood.ubc.ca/.

(b) In the USA, few institutions within the country that offer degrees with a specialization in agro-meteorology such as:

- Iowa State University Department of Agronomy (http://www.agron.iastate.edu/academic/graduate/agrimeteor.aspx) and

- University of Nebraska-Lincoln - School of Natural Resources (http://snr.unl.edu/gradstudent/special/agmet/). In addition, there are a number of schools in the US that offer at least one course related to agro-meteorology or agro-climatology, but do not necessarily offer degrees in these disciplines. Examples of these schools include:

- Auburn University - CSES 7600/7606 AGROCLIMATOLOGY (http://bulletin.auburn.edu/coursesofinstruction/agrn/),

- Cornell University - EAS 6750 - Modeling the Soil-Plant-Atmosphere System (http://ccams.eas.cornell.edu/index.php?page=courses),

- Kansas State University - AGRON 700 - Agricultural Meteorology (http://catalog.k-state.edu/preview_course_nopop.php?catoid=2&coid=182104)

- Michigan State University - GEO 402 - Agricultural Climatology (http://www.geo.msu.edu/extra/andresen/#COURSES)

- Purdue University - several applied meteorology courses (http://catalog.purdue.edu/preview_program.php?catoid=8&poid=9099&returnto=8286) and

(c) Training activities of the National Meteorological Institute (NMI) of Costa Rica and the DSSAT group under the parameters of the University of Gainesville, Fla., However, the geographical information employed is not being used for agro-meteorological applications such as forecasting of pests and diseases because of lack of the required skill or training.

Recommendations: WMO and CAgM in particular should forge a closer link with the AgMIP and DSSAT groups in order to tap into their expertise in crop modelling. Collaboration of CAgM with FAO on these areas (i.e. Cropwat v8, AquaCrop v6 , AquaCrop and SEQUIA-ASIS) should also be encouraged. In addition, collaboration of CAgM with the **Water Foot Print Network, Polytechnique Montreal**, **Institute for Water Education and Cap-Net UNDP** would be beneficial to build capacity of member-states on calculation of water foot print and the development of sustainable water management.

Closer collaboration between CAgM and CIIFEN on agro-meteorological training and applications is also strongly encouraged in order to acquire the necessary knowledge required to solve and minimize inherent weather and climate-related risks to agriculture towards increasing agricultural production in Mexico.

CAgM should establish relationship with the above universities to promote Agro-meteorology training. Finally, provision of training on use of GIS for agro-meteorological applications like forecasting of pests and diseases (i.e. at the University of Gainesville) is highly recommended for NMI of Costa Rica.

2.4 RA V's Identified International Institutions that have Synergies with WMO's Agro-meteorological Training Programmes & Resulting Training Opportunities:

(i) **Agricultural Model Inter-comparison and Improvement Project (AgMIP)** (https://www.agmip.org/about/) on improving substantially, the characterization of world food security under climate change and to enhance adaptation capacity in both developing and developed countries;

(ii) Use of decision support tools like the **Agricultural Production System Simulator (APSIM)** and the **Decision Support System for Agro-technology Transfer (DSSAT),** which are crop simulation programs that enable sub-models (or modules) to be linked to simulate agricultural systems.

(iii) **Climate-Smart Agriculture (CSA)**, which aims to guide actions needed to transform and reorient agricultural systems to effectively support development and ensure food security in a changing climate. Three objectives are the main focus: sustainably increasing agricultural productivity and incomes; adapting and building resilience to

climate change; and reducing and/or removing greenhouse gas emissions, where possible.

(iv) **Graduate Diploma of Science and a Master of Science (Applied Climate Science) at University of Southern Queensland:** with a strong focus on agriculture and meteorology. The degree programme focuses on the impacts of climate variability on natural systems, as well as human and socio-economic activities and is designed to provide graduates with the knowledge and decision-making skills to work as 'climate smart' professionals in many sectors of economic activity, including agriculture, food, water, energy, health and natural resource management industries.

Relevant trainings to the agricultural sector in Australia, including those provided by the Australian Bureau of Meteorology (BoM), Fiji's National Meteorological Services (FMS), Indonesian Agency for Meteorology, Climatology and Geophysics (BMKG) and New Zealand's National Institute of Water and Atmospheric Research (NIWA). Highlights of the trainings from these organizations, as well as those from other member-states from the region (as stated in the attached list of contacts in Appendix1), along with some recommendations:

(a) 2-day courses on "Introduction to Meteorology"; flyers, course syllabus and course timetable are attached in Appendix 2 for provide the necessary guidance;

(b) "Introduction to Climate" to be introduced by the Australian Bureau of Meteorology (BoM) in 2018 to cover topics like 'The Basics of the Atmosphere'; 'The Bureau's Climate Record'; 'Australian Climate Drivers, Seasonal Variability & the Bureau's Climate Outlook Products'; and 'Climate Change, Projections and Impacts'.

(c) **Educational material on BoM's website**, with many explanatory videos and also an online course developed in conjunction with the COMET (Cooperative Program for Operational Meteorology, Education, and Training) organisation; http://www.bom.gov.au/climate/about/,

- http://www.bom.gov.au/climate/ahead/#tabs=About-outlooks-and-influences and https://www.meted.ucar.edu/training_module.php?id=1247#.V5ayI6Ofh5I

(d) **Tools and information about climate to make better decisions about farming business** such as those provided to Australian farmers and their advisors through the "Climate Kelpie" website (http://www.climatekelpie.com.au/).

(e) **Webinars on topics relevant to primary producers and others working in agriculture** are organized by Victoria State Government (i.e. Agriculture Victoria). These focus on a range of topics, including seasonal risk and climate change projections and impacts, adaptation opportunities and also covers a large spectrum in the agricultural industry.

(f) **Basic training for Agricultural Extension officers** on "Weather Observations and Understanding of Weather and Climate Products" provided by Fiji's National Meteorological Services (FMS) in order to assist farmers in the use of weather and climate information in the farming practices. This is done at stakeholder consultation levels, as there is no structured program at FMS. However, **University of the South Pacific (Samoa Campus) and Fiji National University (Suva Campus) have academic programs at Certificate, Diploma and Degree levels**;

(g) **Climate Field Schools (CFS)**: organized by the Indonesian Agency for Meteorology, Climatology and Geophysics (BMKG), which aim at increasing farmers' knowledge on the application of climate information in their weather and climate decision-making activities. More than 25 provinces have benefitted from the three-month field schools where BMKG staff and extension workers meet with farmers every 10 days to discuss how to apply

weather and climate information during the planting and growing season, as well as how to use simple tools, such as rain gauges, and temperature and humidity readings;

(h) **Trainings for representatives of the agriculture sector** is indirectly achieved by New Caledonia and Wallis-et-Futuna weather service, through participations at meetings and/or during training activities in which officials of the weather service provide expertise. Such meetings and/or processes are related to drought, heavy rain and strong wind. The "Indirect" trainings could also focus on monthly and seasonal forecast, radar images, and/or statistical methods. In addition, the fourth Pacific Islands Climate Outlook Forum is expected to be organized in Nouméa in September 2018 and would be dedicated to agriculture;

(i) **Agricultural sciences training, which includes applied sciences and social sciences** are offered by most of the institutions in Malaysia such as Universiti Putra Malaysia. These trainings also include subjects on climatological and meteorological fields. In addition, Malaysia is trying to promote agro-meteorological studies for better understanding among the agricultural communities;

(j) **Training for Agro-meteorologists Training Course (ATC)**, which hitherto has not been provided by Philippines Atmospheric Geophysical and Astronomical Services Administration (PAGASA) since 1988, is planned to be included in their Strategic Program for Human Resource Development in 2020;

(k) **Hundreds of models addressing all kinds of meteorological and hydrological training opportunities** at: https://www.meted.ucar.edu/. These are fall-outs of partnership with COMET and are widely used globally;

(l) **Lots of resources that are looking at climate** such as http://www.nws.noaa.gov/os/csd/pds/index.shtml and https://www.climate.gov/;

(m) **National Integrated Drought Information System (NIDIS) portal**, which is used for all sorts of drought applications, including agriculture: https://www.drought.gov/drought/what-nidis; and

(n) **Climate Resilience Toolkit**: https://toolkit.climate.gov/

Details of most of all these trainings programmes in RA V are stated in table 2.

Table 2: Current training activities in RA V

Country	Institution	Agro-meteorological Training Activities	Recommendation
Australia	Managing Climate Variability - a collaborative program between: - Australian Government Rural Industries Research & Development Corporation and Cotton	Climate Kelpie is for Australian farmers and their advisors. It connects users to tools and information about climate to make better decisions about farming business. The website provides mostly links to content on other websites, which are updated monthly. The topics include: - Manage climate → Making decisions to manage climate variability - Forecasts - Understanding climate - Farmers managing risk	Climate Kelpie is a 'one-stop shop' for climate risk management information and very popular with producers and stakeholders in the agricultural industry. It is a very useful on-line tool in agrometeorological training.

	Research & Development Corporation - Grains Research & Development Corporation (GRDC) - Meat & Livestock Australia (MLA) - Sugar Research Australia (SRA)		
Australia	Government of Western Australia – Department of Primary Industries and Regional Development	The department offers a Plan, Prepare and Prosper five day workshop, which includes a component to identify and plan for projected changes in weather patterns and in the physical resources that support the productivity of the farm enterprise.	The training workshops provided by the Government of Western Australia are recommended to continue to be used as an agrometeorological training tool.
Australia	Victoria State Government – Agriculture Victoria	Agriculture Victoria run regular webinars on topics relevant to primary producers and others working in agriculture, on a range of topics including seasonal risk and climate change projections and impacts, adaptation opportunities and innovative farming practices and soil moisture monitoring.	The training activities offered by the Victoria State Government – Agriculture Victoria covers a large spectrum in the agricultural industry.
Australia	Bureau of Meteorology (BoM)	Bureau provides 2 day Introduction to Meteorology courses externally at a cost of $1000 per attendee. The focus of the course is on: - Atmospheric Characteristics - Global Circulation - Synoptic-scale Systems - Weather Elements - The Forecast Process - Climate Principles - Rainfall Forecasts - Bureau Services Other educational material is provided online.	There is currently no specific agro-meteorological training program offered by the Bureau of Meteorology.
Australia	International Centre of Applied Climate Sciences (ICACS), University of Southern	Dr Roger Stone, from ICACS has been presenting seasonal climate forecasting workshops to farmers and stakeholders in the agricultural industry. Over the past two decades, approximately 20,000 participants have taken part. The one-day workshop gives participants the skills to complete their own forecasts, which can	It is recommended to continue the use of the workshops in future training activates.

<table>
<tr><td></td><td>Queensland</td><td>assist in management practices such as pasture budgeting. The face-to-face dialogue between producers, advisers, extension and adoption practitioners and climate experts has proven to be an effective way to communicate historic and predicted seasonal climate information.
The focus of the workshop is on:
- understanding forecast
- how to interpret the forecast
- apply the knowledge to the agricultural industry to make better decisions</td><td></td></tr>
<tr><td>Australia</td><td>University of Southern Queensland</td><td>• Graduate Diploma of Science – 1 year Full Time
<table>
<tr><th>Semester 1</th><th>Semester 2</th></tr>
<tr><td colspan="2">Mandatory core courses:</td></tr>
<tr><td>AGR8001 Food Security in the 21st Century</td><td>AGR8002 Emerging Technologies in Agriculture</td></tr>
<tr><td>CLI8001 Climate Risk</td><td>AGR8003 Critical Issues in Agriculture</td></tr>
<tr><td colspan="2">Minor/Approved Courses:</td></tr>
<tr><td>AGR2302 Agricultural Machinery</td><td>AGR2301 Agricultural Science</td></tr>
<tr><td>AGR3304 Soil Science</td><td>AGR3303 Agricultural Materials and Post-Harvest Technologies</td></tr>
<tr><td>ENV2201 Land Studies</td><td>AGR3305 Precision and Smart Technologies in Agriculture</td></tr>
<tr><td></td><td>AGR4305 Agricultural Soil Mechanics</td></tr>
<tr><td colspan="2">Climate Theme:</td></tr>
<tr><td>CLI1110 Weather and Climate</td><td>CLI2201 Climate Change and Variability</td></tr>
<tr><td>CLI3301 Climate and Environment Risk Assessment</td><td>CLI3302 Adaptation to Climate Change</td></tr>
</table>
• Master of Science (Applied Climate Science) – 2 years Full Time</td><td>The University of Southern Queensland has re-introduced degrees in agriculture and climate science and is planning to expand the program further in the future.</td></tr>
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<tr>
<td></td>
<td></td>
<td>Explore the impacts of climate and weather
The degree focuses upon the impacts of climate variability on natural systems as well as human and socio-economic activities. This specialisation is designed to provide graduates with the knowledge and decision-making skills to work as ‘climate smart’ professionals in many sectors of economic activity including agriculture, food, water, energy, health, and natural resource management industries.
<table>
<tr><th>Semester 1</th><th>Semester 2</th></tr>
<tr><td>CLI8001 Climate Risk</td><td>CLI3302 Adaptation to Climate Change</td></tr>
<tr><td>CLI8204 Global Environmental Systems</td><td>CLI8205 Climate & Sustainability</td></tr>
<tr><td>CLI8802 Climate, Human & Environmental Health & Disaster Management</td><td>CLI8003 Climate, Food, Water & Energy Security</td></tr>
<tr><td>MSC8001 Research Project I</td><td>MSC8001 Research Project II</td></tr>
<tr><td>Approved Course (2)</td><td>Approved Course (2)</td></tr>
</table>
</td>
<td></td>
</tr>
<tr>
<td>Fiji</td>
<td>Fiji National Meteorological Services (FMS)</td>
<td>FMS do provide basic training for Extension Agricultural officers on weather observations and understanding of weather and climate products to assist farmers to use weather and climate information in farming practices. This is done at stakeholder consultation levels.</td>
<td>It is recommended to maybe extend the training program if possible, or otherwise to continue in the current form.</td>
</tr>
<tr>
<td>Indonesia</td>
<td>Indonesian Agency for Meteorology, Climatology and Geophysics (BMKG)</td>
<td>The BMKG has been running Climate Field Schools (CFS) with the aim to increase farmers’ knowledge on the application of climate information in their decision making. More than 25 provinces have benefitted from the three-month field schools where BMKG staff and extension workers meet with farmers every 10 days to discuss how to apply weather and climate information during the planting and growing season as well as how to use simple tools, such as rain</td>
<td>The training program has been very successful. The user outreach approach of the CFS is in line with the aims of the Global Framework of Climate Services (GFCS), which seeks to bring together providers and users of climate services. Agriculture</td>
</tr>
</table>

		gauges, and temperature and humidity readings. This is achieved through: - Teaching and spreading the basic meteorological and Climatological knowledge among farmers communities and to turn it into a practical language. - Helping farmers to improve their activity by sharing with them weather insight and by identifying the different causes of crop damages. - Contributing to improve food security in Indonesia. - Building partnerships with farmers to improve BMKG observations by setting up a set of equipment in their field.	production and food security is one of the top priorities of the GFCS.
New Zealand	National Institute of Water and Atmospheric Research (NIWA)	NIWA provides analyses and expert advice to companies and to the Government related to climate risk to agriculture. A number of on-line tools are available on a yearly fee based subscriptions to help farmers to improve decision-making, mitigate farm environment risk, and to become more productive, efficient, competitive and sustainable. E.g. - IrriMet: online irrigation decision-support tool - NIWAFarmMet: online site-specific two-day, six-day and two-week weather forecasts, animated national rainfall forecast maps (two-day and six-day), site-specific growing degree days, soil moisture balance, accumulated rainfall, air temperature and days with frost	The individual on-line agrometeorological training tools provided by NIWA are limited and require a yearly fee based subscription. It is recommended to continue the use of these training tools.

Recommendations: WMO should forge a closer link with **AgMIP** on food security and climate change adaptation training programmes, while WMO and in particular CAgM should establish closer links with the organisations associated with these very important projects/ tools (i.e. **APSIM, DSSAT** and **CSA).** Closer relationships with the universities for promotion of Agro-meteorology degree courses is recommended along with the use of Climate Kelpie (a 'one-stop shop' for climate risk management information and very popular with producers and stakeholders in the agricultural industry, as well as a useful on-line tool in agro-meteorological training). There is also need to expand the training for agricultural extension officers organized by Fiji National Meteorological Services (FMS). In addition, the user outreach approach of the Climate Field School (CFS) is highly commendable and recommended for other Member-States of WMO. This is because it is in line with the aims of the Global Framework of Climate Services (GFCS), which seeks to bring together providers and users of climate services. Agriculture production and food security is also one of the top priorities of the GFCS.

3.0 Activities Carried Out Under TOR 2: Identify training needs required to improve agricultural meteorological services that meet user requirements

3.1 RA I's Expressed Agro-Meteorological Training Needs: Training courses in the following areas would significantly improve capability of the agro-meteorologists to adequately meet users' requirements in the region:

(i) Development of portable software tools such as GeoWRSI and GeoCLIM, which can respectively strengthen capacity of Agro-meteorologists in estimating the water requirement satisfaction index and in making climatological analysis;
(ii) Climate Risk Analysis in Agriculture;
(iii) Modelling the impact of climate change on agricultural pests, diseases and weeds;
(iv) Soil moisture management and irrigation scheduling in a changing climate;
(v) Agricultural sustainability and crop yield forecasting using climate data;
(vi) Climate Smart Agriculture in collaboration with FAO;
(vii) Crop modeling for bio-farming/organic farming in collaboration with some related regional or international institutions like AGRHYMET;
(viii) Use of GIS.

The region also expressed the following trainings needs to improve infrastructural and manpower supports:

(ix) Basic agro-met trainings for service providers
(x) Provision of fellowship awards to acquire necessary knowledge and skills;
(xi) Development of practical knowledge in agro-met in support of the farming community;
(xii) Development of courses for specific programmes to better support agro-met services; and
(xiii) Introduction of competency frameworks that will define standards and recommend practices for services of agro-met, as well as provision of training courses and programmes to better support the competency frameworks.

3.2 RA III's Expressed Agro-Meteorological Training Needs: A survey on Training Needs in RA III was carried out for all the NMSs in the region. This is also an initiative of Dra. Celeste Saulo (the Director of NMS Argentina) in her role in Capacity Building in RA III. The survey was based on WMO Competency Framework and the target audience are climate personnel and heads of units/departments with responses from 28 countries as shown in figure 1.

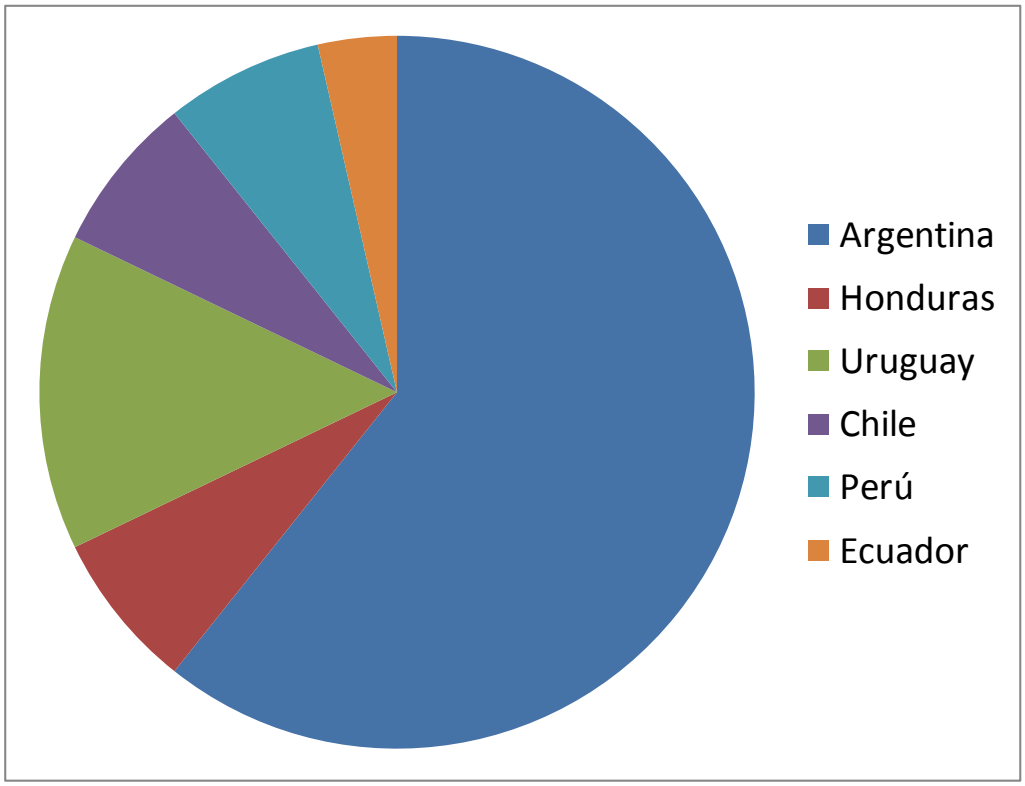

Fig 1: Distribution of the Target Audience considered for the Survey on Training Needs for Climate Services in 28 Countries in RA III

The survey focused on the level of training interests expressed by the climate staff in the following 5 areas:

(a) Creation and management of climate data sets;
(b) Deriving products from climate data;
(c) Predicting future states of the climate at different spatial and temporal resolutions;
(d) Ensuring the quality of climate information and services; and
(e) Communication of climatological information to users.

Responses received showed that majority of the correspondents expressed high interest in all the five areas, although a significant number did not consider trainings on prediction, quality and communication of climatological information relevant to their jobs. In addition, in the area of communicating climate information, it is interesting to note the indifference and low level of interest expressed in topics "f" and "g", i.e. "Comply with the interfacing requirements of the GFCS" and "Comply with the Integration within the WMO WIS system" respectively. Similar observation is applicable to training on prediction of future climate ("3i" and "3j"); a significant level of indifference and low interest was expressed on the creation of value-added products, such as graphics, maps and reports to explain climate forecasts and climate model information for the **agriculture** and the **marine meteorology** sectors (two very relevant sectors to CAgM). Details of the topics expected to be covered for each of the 5 trainings areas are stated below, along with graphical illustrations of the survey results in figures 2-6.

(a) **Creation and management of climate data sets.**

(i) Conduct data climate data rescue procedures.
(ii) Apply quality control processes to climate data to identify and evaluate suspect data.

(iii) Apply – when necessary – spatial and temporal interpolation to ensure data continuity.

(iv) Collect and store in relational databases climate data and metadata; Create, archive and document climate datasets of the appropriate length, time resolution and units.

(v) Assess climate data homogeneity and adjust inhomogeneous time series where possible.

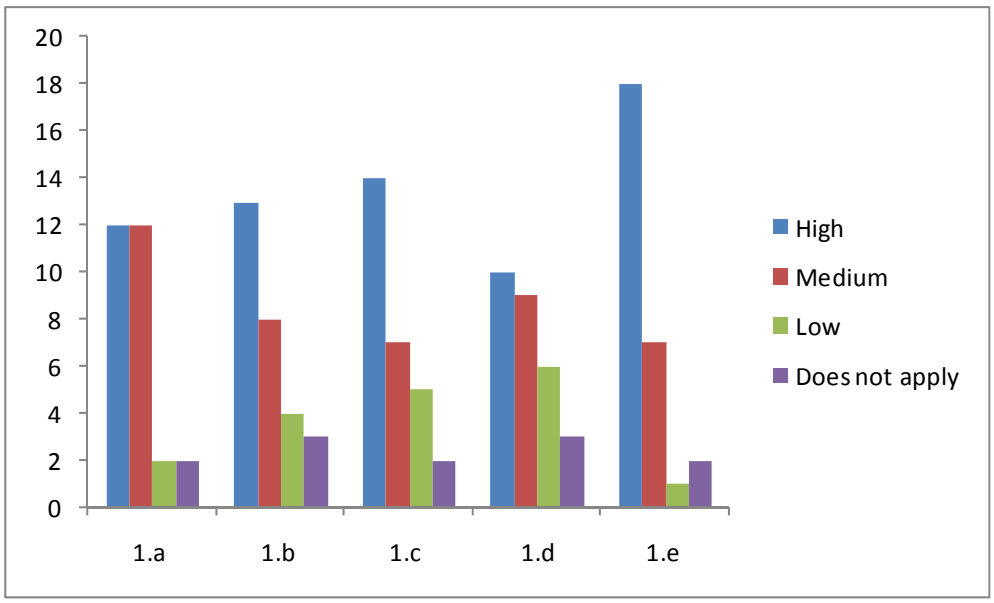

Fig 2: Training Interests on Creation and Management of Climate Data Sets

Deriving products from climate data.

(vi) Identify and retrieve adequate climate data from different sources (observed, reconstructed, reanalysis, satellite, model) to generate climate products.

(vii) Compute basic climate products, such as normals, or anomalies defined relative to a reference period.

(viii) Compute Climate Indices for the monitoring of climate change and climate extremes.

(ix) Compute sector-specific Climate Indices and other sector-oriented climate products.

(x) Apply statistical and geo-statistical analysis to monitor the spatial distribution and temporal evolution of climate.

(xi) Create value-added products, such as graphics, maps and reports to explain climate characteristics and evolution, according to the needs of specific sectors such as **health**.

(xii) Create value-added products, such as graphics, maps and reports to explain climate characteristics and evolution, according to the needs of specific sectors such as **agriculture**.

(xiii) Create value-added products, such as graphics, maps and reports to explain climate characteristics and evolution, according to the needs of specific sectors such as **water**.

(xiv) Create value-added products, such as graphics, maps and reports to explain climate characteristics and evolution, according to the needs of specific sectors such as **disaster management**.

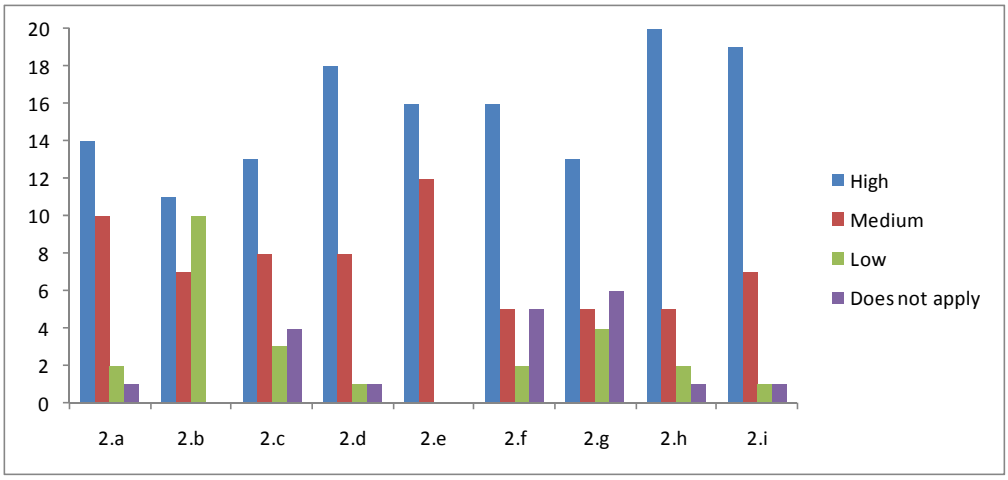

Fig 3: Training Interests on Deriving Products from Climate Data.

(b) Predicting future states of the Climate at Different Spatial and Temporal Resolutions;

(i) Create sub-seasonal forecast products.

(ii) Create seasonal forecast products.

(iii) Locate, select and retrieve climate forecasts and climate models output generated by Regional Climate Centers, Global Producing Centers and other institutions to complement self-produced climate products.

(iv) Apply statistical and geo-statistical analysis, including downscaling, to monitor the spatial distribution and temporal evolution of model output.

(v) Evaluate the performance of climate models output and quantify the associated uncertainties.

(vi) Create value-added products, such as graphics, maps and reports to explain climate forecasts and climate model information for **health** sectors.

(vii) Create value-added products, such as graphics, maps and reports to explain climate forecasts and climate model information for **disaster management** sectors.

(viii) Create value-added products, such as graphics, maps and reports to explain climate forecasts and climate model information for **energy** sectors.

(ix) Create value-added products, such as graphics, maps and reports to explain climate forecasts and climate model information for **agriculture** sectors.

(x) Create value-added products, such as graphics, maps and reports to explain climate forecasts and climate model information for **marine meteorology** sectors.

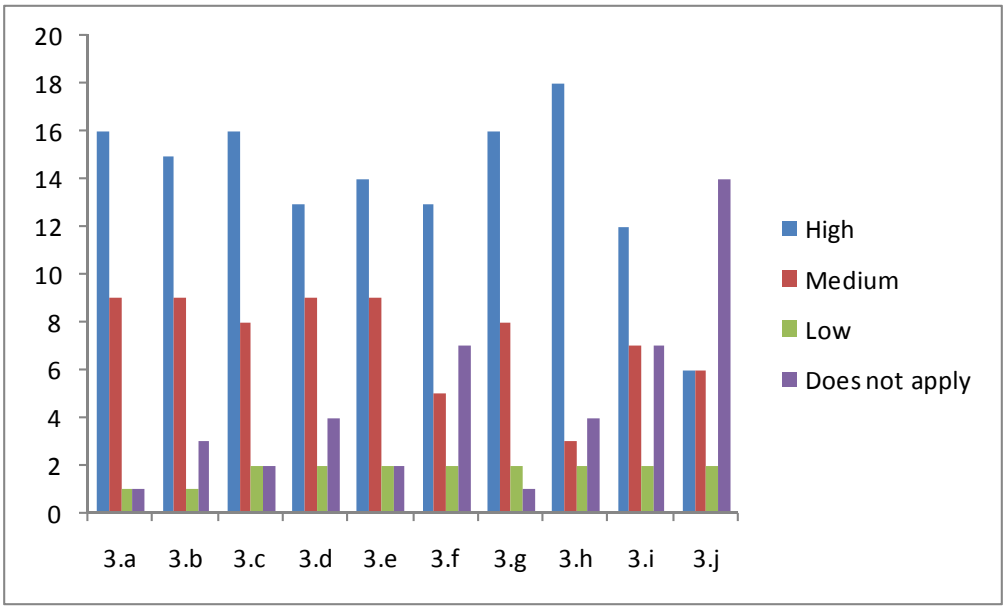

Fig 4: Training Interests on Predicting Future States of the Climate at Different Spatial and Temporal Resolutions.

(c) Ensuring the quality of Climate information and Services

(i) Climate information and services are defined and routinely updated.

(ii) Best Practices are followed and/or Guidelines and Quality Management Procedures for climate information are created and routinely maintained. Monitoring processes of the climate services are documented and used in quality control activities.

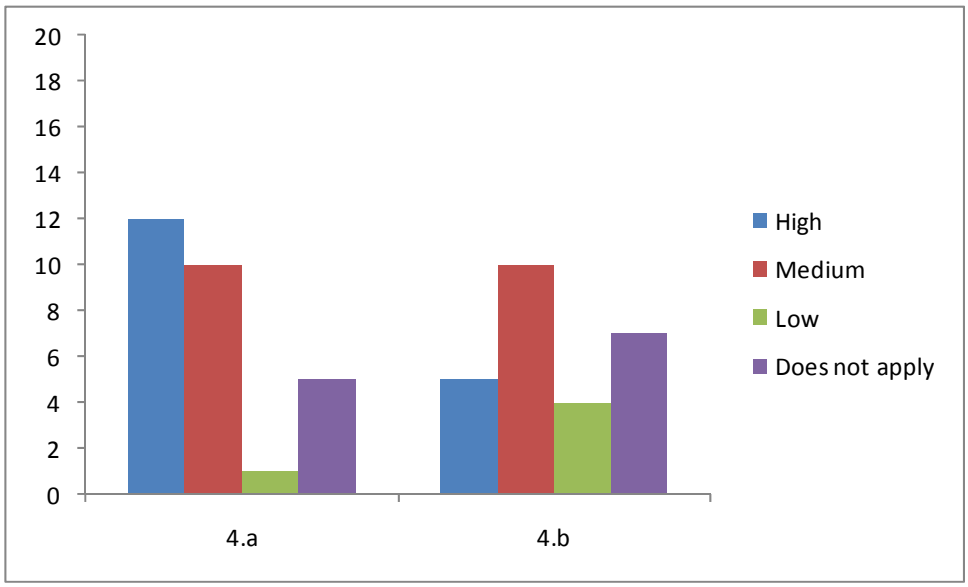

Fig 5: Training Interests on Ensuring the Quality of Climate Information and Services

(d) Communication of Climatological information to Users.

(i) Data are communicated to policy makers, stakeholders and the general public.

(ii) Climate science and products are communicated to policy makers, stakeholders and the general public.

(iii) Conduct and evaluate user satisfaction surveys on a regular basis.

(iv) Revise climate services and their communication based on user feedback.

(v) Develop and apply, in partnership with users, specific applications to facilitate the understanding and use of the climate products and services.

(vi) Comply with the interfacing requirements of the GFCS.

(vii) Comply with the Integration within the WMO WIS system.

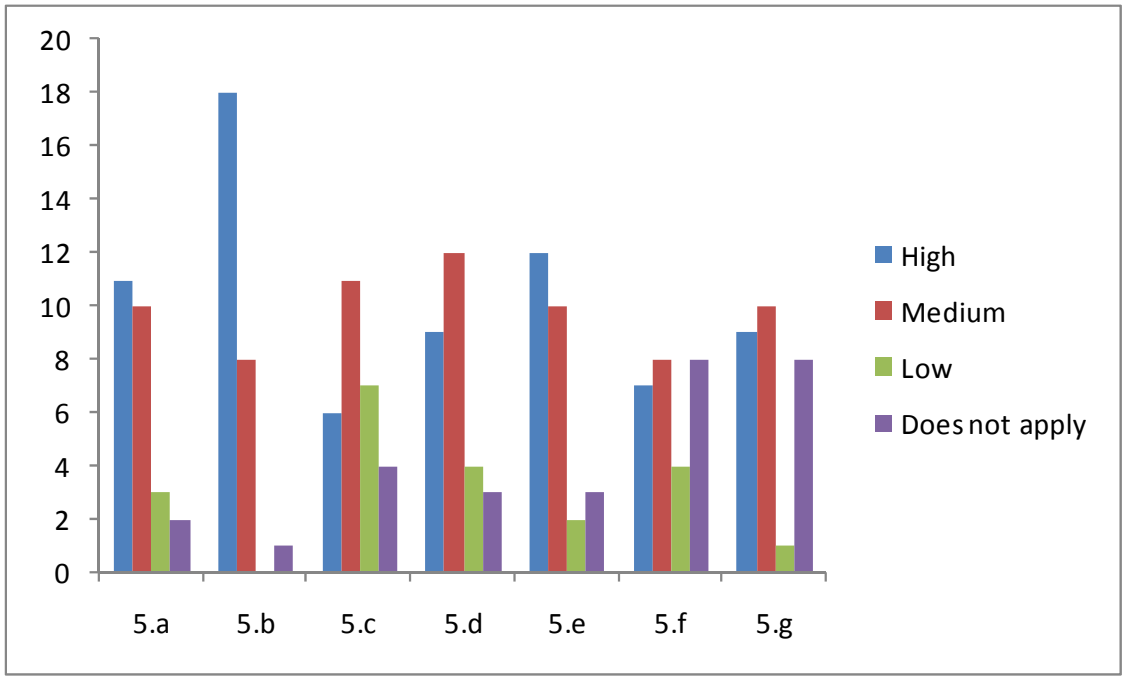

Fig 6: Distribution of Training Interests on Communication of climatological information to users

Recommendation: There is need to create more awareness on the relevance of climate information to agriculture and food production, as well as encourage development and communication of the necessary agro-related climate information services' products to the sector.

3.3 RA IV's Expressed Agro-Meteorological Training Needs: Due to the predicted future climate change, agro-meteorological training is required in the following areas. These can be offered by WMO training centres and or WMO affiliated training centres:

i) Climate Risk Analysis in Agriculture;
ii) Modelling Impact of climate change, global warming and climate variability on agriculture (both crops and livestock);
iii) Modelling impact of climate change on agricultural pests, diseases and weeds;
iv) Agricultural sustainability and crop yield forecasting;
v) Application of weather forecasts to improve agricultural production in a changing climate;
vi) Application of remote sensing to agriculture including pests and disease monitoring;
vii) Droughts, floods and extreme temperatures preparedness and adaptation;
viii) Modification of microclimate to improve agricultural production;

ix) Soil moisture management and irrigation scheduling in a changing climate;
x) Forecasting crops phenological stages (i.e., flowering, sprouting, maturity);
xi) Adaptation and mitigation strategies for agriculture in a changing climate;
xii) The role of agro-meteorology in a changing climate
xiii) International course in meteorological application in agriculture for Agro-meteorologist trainees at **Santa Cruz de la Sierra, Bolivia**. Similar programmes also exit in Israel and China;
xiv) Educating the farming community on how weather and climate information can be used to improve agricultural productivity and sustainability in the US. This can be obtained from various groups with university or government ties that engage in extension activities such as:

- **The Agro-climate (http://agroclimate.org/):** This is an excellent example of a university-based extension program within the United States. Agro-Climate is working toward expanding their efforts to Africa and South America.

- **The National Drought Mitigation Centre (NDMC) (http://drought.unl.edu/):** This was established at the University of Nebraska-Lincoln in 1995 to help people and institutions develop and implement measures to reduce societal vulnerability to drought. It focuses more on preparedness and risk management rather than crisis management. The NDMC works with stakeholders to ensure that their science-based tools meet user needs.

- **The USDA Climate Hubs (https://www.climatehubs.oce.usda.gov/):** These hubs are relatively new initiatives that began in 2014. The mission of the Climate Hubs is to develop and deliver (along with USDA agencies and partners) science-based, region-specific information and technologies to agricultural and natural resource managers that enable climate-informed decision-making, and to provide access to assistance to implement those decisions. As part of these efforts, Climate Hub staff also 1) provides outreach and education to farmers, ranchers, and forest landowners on science-based risk management; 2) educates natural and agriculture resource managers on the latest understanding of climate science and the effects of climate change on working lands, and 3) engages with stakeholders and partners in innovative and interactive ways to help lower the barriers to adaptation, manage risk, and enhance rural productivity. There are currently 10 Regional Climate Hubs that serve the United States and its territories.

- (xv) Generating quality agro-meteorological data through the establishment of wider and more robust network of agro-meteorological stations that operate within WMO's set standard in Mexico. This is to ensure effective planning and execution of agricultural projects and activities such as forecasts of phenological phases, harvests, drought, frost, forest fire and pest and diseases. This need arose as a result of challenges of poor quality and inadequate network of agro-meteorological stations in Mexico, which makes it difficult to have adequate data definition (meteorological, or climatological agricultural) for each crop. Presently, there is only the network at its National Research Institute in Forestry, Agricultural and Livestock (INIFAP), which actually operates as climatological station network. It is poorly equipped and does not follow WMO standard.

(xvi) Mexico's training needs was summarized under 3 headings namely:

(a) Operational Agricultural Activities: Scheduling of planting dates;
Forecasting of phonological phases (i.e. flowering, sprouting, maturity, harvest, and pruning), frost, pest & diseases, forest fire, crop and drought; Effective application of irrigation water (quantity, quality and opportunity); Monitoring of crop development for technical assistance like Bayer in Germany; Management of controlled environments: greenhouse, shading, sun and other

requirements; and New and effective methodologies for the estimation of Cold Hours and Hear Units with different sensors.

(b) Agricultural Planning Activities: Management of land-use area; Crop Zoning; Adaptation of crop and animals; Pastures and livestock management; Planning water use in agriculture and Development of Early Warning/Forecast of agricultural disasters and

(c) Agricultural Research Activities: Optimization of the use and management of water; Genetic improvement of plants and animals; Phenological characteristics of of crops; Optimization of agronomic practices; Integrated management of pests and diseases; Introduction to potential crops; Analyses of research results; Animal performance and environment; Forest exploitation; Prevention of casualties: fire, frost, drought, hail, etc.; and Balance of energy in plants and animals.

Others include: Studies of soil erosion; to chose suitable place for fruit tree, vegetables and ornamentals; development of agricultural calendars; agro-climatic zoning for different crops; regionalization techniques; tools for planning different agricultural activities with or without climate change, i.e. agricultural practices to meet cold wheat requirements; and soil studies for agricultural purposes, growth factors of different crops and forecasting models.

In addition are: -Solar radiation and photosynthetically active radiation, photoperiod, photosynthesis and respiration, and net photosynthesis; Temperature and crops, cold number of hours, heat unit and thermal constants; Methods of defence against frost, frost-free period, probability of occurrence of frost; Atmospheric humidity; psychrometer and psychrometric table, evaporation in the atmosphere; real and potential evapotranspiration, quantification of evapotranspiration, measurement and estimation of climatic and real water balance; Lysimeter, evapotranspirometer application in field working-automatic stations; and Meteorological and climatic requirements in severe weather for different crops, i.e. bananas in Tabasco and Oaxaca.

Finally, other areas of agricultural research in Mexico include: Climate as a resource; Remote sensing in agricultural meteorology; Formation of a GIS; RGB; different resolutions; spectral signatures vs. phenology; humidity and water balance; Numerical crop models, irrigation needs, water balance at different scales, carbon balance and phenology for cereals; Drought; climatic data, soil moisture, levels of dams and lakes, flows, groundwater, water footprint, perspective and evaluation of cost vs. types of drought; Evaluation of crop prediction with agro-meteorological data and meteorological-phenological reports; Climatology and climatic variability applied to agriculture; ocean indicators and agriculture, variability and extreme values; Climate change, climate system and possible risk and impacts on different crops; Concept of threat vulnerability, risk, exposure, hazards, uncertainties, changes in land use, risk management, GIS applied to risks and impacts; phytosanitary pressure in conditions of drought and flood, preparation of early warnings in case of risk (disaster cycle). Agricultural insurance and statistics, statistical and dynamic regionalization, numerical models of forecast applied to different crops; Climate change policies in Mexico with respect to different crops; Generation of agro-climatic products; Training on understanding and production of the National Action Plan for the reduction and management of risks (vulnerability and threat) of disaster in the Agricultural Sector and the Food and Nutritional Security of Mexico; Development of Information Systems and support for decision making in agro-climatic and agro-meteorological risk management; Monitoring of Forest Fires possibility with satellite and GIS images (farmers in Mexico have different approaches in agricultural production and other countries are not likely to have different classification or approaches. However, the more prepared people are, the greater their gain in the production and marketing of their agricultural products).

Recommendation: Mexico's research efforts are highly commendable. WMO/CAgM need to provide adequate fora to enable Member-States of RA IV and other Regional Areas share in these wealth of agro-meteorological research knowledge and experience.

3.4 RA V's Expressed Agro-Meteorological Training Needs: In order to improve agricultural meteorological services in RA V, the following trainings are suggested:

- Climate Risk Analysis;
- Impact of climate change and variability;
- Extreme climate events: Droughts, floods, heatwaves, frost;
- Seasonal climate forecasting for agriculture production;
- Soil moisture management;
- Irrigation scheduling;
- Crop modelling;
- Application of remote sensing in agriculture;
- Modelling of optimum planting time, fertilisation and pest control; and
- Adaptation and mitigation strategies for agriculture;

4.0 Activities Carried Out Under TOR 3: Recommend which training activities (i.e. modules, exercises, distance learning, seminars) should be further used in agro-meteorological training)

4.1 RA I's Recommended Trainings Activities for Future Use in Agro-meteorological Trainings: Reports received from some of the member-states like Mauritius show that combination of all the training methods would be useful for future agro-meteorological trainings in the region. However, more preference is given to the distance-learning approach because it is cheaper as it does not require the movement of personnel.

On the other hand, training through seminars is also considered very important following opportunities it provides for networking and sharing of information and expertise.

In addition, continuation of the METAGRI programme in the region along with the use of the following agro-met training programmes are still very much relevant and are highly recommended:

(a) Agro-meteorological Services for Water Use

(i) Irrigation Scheduling and

(ii) Identification of Water needs

(b) Agro-meteorological Services for rain-fed agriculture
   i. Crop modelling
   ii. Early Warning Service & Communication and

(c) Agro-meteorological Services for livestock and fisheries
   iii. Heat stress index.

4.2 RA III's Recommended Trainings Activities for Future Use in Agro-meteorological Trainings: In RA III, 53 training programmes were identified as listed in Table 1. 19 out of these are recommended for further use in agro-meteorological training programmes. The 53 courses have been carried out in the last 5 years and consist of **14** international ones, **12** from Argentina, **6**

courses each from Brazil and Chile, **4** courses each from Paraguay and Peru, **3** courses each from Ecuador and Uruguay and one (**1**) course from Bolivia. However, only 25 of these focus on agro-meteorology/agro-climatology as listed below, while the rest are mainly based on Climate Change:

(i) Four (4) International Agro-Meteorological Courses:

- "Agro-climatic risk management in Latin America": http://bit.ly/1z2Clri), organized by Food and Agriculture Organization (FAO);
- "AGRIMONITOR: agricultural policy, food security and climate change": http://bit.ly/2oaCNNC, provided by Inter-American Development Bank (BID); and
- "Water Balance": http://bit.ly/2Ge9ukL, organized by National Meteorological Services of Argentina.
- "MOOC: Introduction to the use and representation of Geospatial Information": http://bit.ly/2o4V5k7, organized by Inter-American Institute for Cooperation on Agriculture;

(ii) Six (6) Agro-Meteorological Courses from Argentina:

- "Climate and Crop Diseases": http://bit.ly/2F679Jc, organized by National Institutes of Agricultural Technology;
- "Workshop on Sustainable Soil Management and Desertification":http://bit.ly/2ExsqdC, organized by National Institutes of Agricultural Technology;
- "Climate information for risk management in the agricultural sector": http://bit.ly/2oaCv9F, organized by National Institutes of Agricultural Technology;
- "Water balance modeling":http://bit.ly/2EKeXTj, organized by Buenos Aires University;
- "Agricultural bioclimatology and agro-climatology": http://bit.ly/2EKeXTj, organized by Buenos Aires University; and
- "Agronomic application simulation models": http://bit.ly/2sCyYXg, organize by Buenos Aires University;

(iii) Four (4) Agro-Meteorological Courses from Brazil:

- "R Software Training and Applications in Agro-meteorology": (http://bit.ly/2GhX4lC), organized by USP (São Paulo University) at Escola Superior de Agricultura "Luiz de Queiroz", São Paulo University;
- "Course on Agro-meteorology": (http://bit.ly/2HjbTMk) organized by Embrapa (Brazilian Agricultural Research Company, Ministry of Agriculture), at Agronomic Institute of Pernambuco (IPA), Recife;
- "Knowing the agro-meteorological monitoring system Agritempo": http://bit.ly/2oaeek5) organized by Embrapa ((Brazilian Agricultural Research Company, Ministry of Agriculture) at Campus of Campinas University (Unicamp - Barão Geraldo, Campinas San Pablo); and
- "AGRITEMPO Agrometeorological Monitoring System": (http://bit.ly/2sy4CVB), organized by Embrapa (Brazilian Agricultural Research Company, Ministry of Agriculture) at Santo Antônio de Goiás, Brazil;

(iv) Three (3) Agro-Meteorological Courses from Paraguay:

- "Water Balance operative for agriculture (BHOA)":http://bit.ly/2C1HP8K, organized by Inter-American Institute for Global Change Research, Project CRN-3035;
- "Maps of Agricultural Risk in Paraguay":http://bit.ly/2oamEHY, organized by Inter-American Institute for Global Change Research, Project CRN-3035; and
- "Course on Statistical Package R": http://bit.ly/2CnMayJ, organized by Inter-American Institute for Global Change Research, Project CRN-3035;

(v) Two (2) Agro-Meteorological Courses from Chile:

- "Training in agro-meteorology": (http://bit.ly/2EkrR3v) organized by INIA (National Institute of Agricultural Technology) at Quilamapu – Chillán; and
- "Training course in agro-meteorology": (http://bit.ly/2BAwDP4)g organized by UTALCA (Talca University) at Center for Research and Transfer in Irrigation and Agro-climatology (CITRA), from School of Agricultural sciences;

(vi) Two (2) Agro-Meteorological Courses from Ecuador:

- "Training workshop in agrometeorology, oriented to Climate Change and agriculture": http://bit.ly/2o3oCdX), organized by National Institute of Meteorology and Hydrology; and
- "Course of Geographic Information Systems applied to the management of the territory": http://bit.ly/2F7QLYC organized by Ecuadorian Space Institute;

(vii) Two (2) Agro-Meteorological Courses from Uruguay:

- "Course on Agro-meteorology": http://bit.ly/2F7uRVt, organized by School of Agronomy, University of the Republic (FAGRO); and
- "Workshop on the use of the SWAT model": http://bit.ly/2CpiT6H ,organized by National Institutes of Agricultural Technology (INIA);

(viii) One (1) Agro-Meteorological Course from Perú:

- "Agricultural Soil and Agro-meteorology": (http://bit.ly/2F9LcsY) organized by Agrarian, Regional Direction; and

(ix) One (1) Agro-Meteorological Course from Bolivia:

- "International course on Applied Agro-meteorology": http://bit.ly/2ElwFGH, organized by FAO at La Paz, Bolivia.

Recommendations: More efforts should be made in increasing agro-meteorological training programmes in the region. Especially in the areas of forecast for the agricultural sector and agro-climate information systems, as well as how to reach the users. There is also need to develop more suitable agro-meteorological training programmes for the region as it appears that many of the courses are not taught regularly and several of them are not available currently.

4.3 RA IV's Recommended Trainings Activities for Future Use in Agro-meteorological Trainings: All the earlier identified training activities are required. However, there is a need to constantly update and upgrade the trainings.

4.4 RA V's Recommended Trainings Activities for Future Use in Agro-meteorological Trainings: Almost all the training activities in the extensive list of existing agro-meteorological training activities in the region as stated in table 2 are recommended for continuous use in future training activities, as they are of benefit to the agricultural industry.

Recommendations: There is however need to establish a central location / website where all training courses can be listed with contact details and such a website should be updated at regular intervals.

The following agro-meteorological training programmes and tools are also recommended for future use in the region. Notable among them are: (a) the series of one-day Managing for Climate Variability (MCV) workshops provided by Dr. Roger Stone and colleagues of the International Centre of Applied Climate Sciences (ICACS) at the University of Southern Queensland, (b) the five-day workshop organized by Government of Western Australia's Department of Primary Industries

and Regional Development and (c) the four-year Drought and Climate Adaptation Program (DCAP) and 9 programmes and series of projects, as well as the individual on-line agro-meteorological training tools provided by NIWA.

(a) Seasonal climate forecasting workshops for farmers and stakeholders in the red meat and sugar industry. These are series of one-day Managing for Climate Variability (MCV) workshops provided by Dr. Roger Stone and colleagues of the International Centre of Applied Climate Sciences (ICACS) at the University of Southern Queensland. The workshops give participants the skills to complete their own forecasts, which can assist in management practices such as pasture budgeting. This training programme is an effective way to communicate historic and predicted seasonal climate information, as it also provides a face-to-face dialogue between producers, advisers, extension and adoption practitioners, as well as climate experts. The focus of these course-programmes is on:

- Understanding and interpreting the forecast in order to effectively apply the acquired knowledge to the industry and make better decisions, as well as take ownership of the programmes;

(b) Five-day workshop organized by Government of Western Australia's Department of Primary Industries and Regional Development. The workshop includes a component to identify and plan for projected changes in weather patterns and in the physical resources that support the productivity of the farm enterprise.

(c) The four year Drought and Climate Adaptation Program (DCAP), which started in 2018, is an initiative to improve drought preparedness and resilience for Queensland producers. DCAP consists of a number of innovative projects that are managed and funded through a series of partnerships with the Queensland Government and industry partners. The largest partnership is the establishment of the Queensland Drought Mitigation Centre (QDMC) with the University of Southern Queensland (USQ), the Department of Science, Information Technology and Innovation (DSITI) and the Bureau of Meteorology (BoM).

The nine programs associated with DCAP aim to improve seasonal forecasts for northern Australia, providing decision support tools for farm managers, and providing advice on climate change projections at regional level, and how to adapt to the changing climate. These programs provide answers to some crucial agro-meteorological concerns as stated below:

1. **"inside edge" knowledge for graziers to master Queensland's drought prone climate** - an innovative research that will give Queensland graziers the "inside edge" to master drought-prone climate, enabling proactive climate responsive business decisions. This project will yield climate-savvy graziers that will continuously adapt to Queensland's variable and changing climate.
2. **Understanding baseline climate through the use of paleoclimate data to plan and prepare for extreme events and floods in Queensland-**uses paleoclimate data to produce a 1000 years rainfall record for Queensland which better describes the risk of extreme droughts and floods.
3. **Enabling drought resilience and adaptation: A program of social research and knowledge support**- an applied research project that will engage directly with Queensland graziers, extension officers and scientists to identify barriers to drought

preparedness, and strategies to assist the grazing industry to improve business resilience and adaptation to drought.

4. **Northern Australia Climate Program (NCAP) –** involves an innovative drought and climate variability Research, Development & Extension (RD&E) to enhance business resilience and build producer capacity to manage climate risk across the northern Australian red meat industry. Graziers across northern Australia will be directly supported through improved seasonal climate forecasts, development of information products for grazier decision making and integration of this information into existing and new extension activities.
5. **Producing enhanced crop insurance systems and associated financial decision support tools – Phase 2:** Recommendations will be developed for agricultural industries and the insurance industry on how more affordable insurance products and viable markets for agricultural insurance products can be established and maintained for Queensland rural industries.
6. **Delivering integrated production and economic knowledge and skills to improve drought management outcomes for grazing systems:** The economic impacts of grazing management decisions will be analysed to improve the capacity of businesses to manage the productivity and profitability challenges of droughts in Queensland. Following the assessment, the skills and knowledge of managers of Queensland grazing businesses will then be developed and supported to assess the economic implications of on-farm drought management decisions.
7. **Using BoM multi-week and seasonal forecasts to facilitate improved management decisions in Qld's vegetable industry:** Improved temperature forecasts will be developed and customised to enhance farm management decision making in the Queensland vegetable industry and improve the capacity of the horticulture industry to manage climate variability and adapt to a changing climate.
8. **Grazing Futures BMP: Promoting a resilient grazing industry:** Grazing businesses across western Queensland will identify and implement changes on-farm, which improve business resilience to drought and climate extremes and deliver enhanced community and economic development outcomes and
9. **Forewarned is forearmed (FWFA): Equipping farmers and agricultural value chains to proactively manage the impacts of extreme climate events:** Improving and customising forecasts of extreme rainfall and temperature events will be developed to help primary producers to make more informed short and medium term management decisions to improve farm profitability in Queensland's grazing and sugar industries.

(d) **Training on analyses and provision of expert advice related to climate risk to agriculture to companies and to the Government by New Zealand's National Institute of Water and Atmospheric Research (NIWA):** also makes a number of on-line tools are available on a yearly fee based subscriptions to help farmers to improve decision-making, mitigate farm environment risk, and to become more productive, efficient, competitive and sustainable. Examples of such tools are:

- IrriMet: online irrigation decision-support tool;

- **NIWAFarmMet:** online site-specific two-day, six-day and two-week weather forecasts, animated national rainfall forecast maps (two-day and six-day), site-specific growing degree days, soil moisture balance,

accumulated rainfall, air temperature and days with frost.

In addition, most of the trainings related to agricultural meteorology in New Zealand are conducted in the context of broader agricultural or meteorological training such as:

- **The Bachelor of AgriScience (Agriculture) at Massey University**, &

- **Training for meteorologists,** conducted by New Zealand Met Service to support weather forecasting for rural (farming) areas of the country.

5.0 Activities Carried Out Under TOR 4: Review the agro-meteorological training opportunities and methodologies from funded projects and in collaboration with the Global and National Agro-meteorological Societies.

5.1 RA I's Agro-meteorological Training Opportunities/Activities From Funded Projects: One of the major funded projects over RAI is the METAGRI project. The project provided ample opportunities for the countries in the region to enable them make significant contributions to their respective national food production/food security by improving rural farmers' knowledge in the application of meteorology to agriculture. A total of 15 countries, namely: Burkina Faso, Cap Vert, Cote D'Ivoire, Ghana, Republique de Guinée, Guinée Bisau, Liberia, Mali, Mauritanie, Niger, Nigeria, Sénégal, Sierra Leone, Tchad and Togo benefitted. Unfortunately, it is now limited to only Mali, Burkina Faso and Niger.

However, over the last couple of years, most other countries in the region such as Mauritius have not benefitted much from funded projects.

There is also no reported jointly funded agro-met project with the Global and National Agro-meteorological Societies over the region.

Recommendations: Resumption of the METAGRI project in those countries where it has been discontinued, as well as its extension to the rest of RA1 member-states is therefore highly recommended. In addition, jointly funded agro-met projects with the Global and National Agro-meteorological Societies are highly desirable for the region. There is also need to encourage collaborations between RTCs of WMO and the Institute of Biometeorology of the Italian National Research Council (CNR-IBIMET) and the AGRHYMET Regional Centre.

5.2 RA III's Agro-meteorological Training Opportunities/Activities From Funded Projects: 17 out of the 53 identified training programmes as stated in Table 1 are from funded projects. These consist of 12 international courses, 4 from Paraguay and one (1) from Bolivia. Table 1 also contains the training activities web pages, and complementary information.

Recommendation: Closer collaborations are encouraged between funding agencies and NMHSs in the region towards achieving the desired increase.

5.3 RA IV's Agro-meteorological Training Opportunities/Activities From Funded Projects: There are very few funded projects in RA IV such as the following ones reported by Mexico:

(i)Universidad Nacional Autonoma de Mexico, Universidad Autonoma Metropolitana and Colegio de Postgraduados (Montecillo,Estado de Mexico), which offers agricultural careers and related training courses in Chapingo, Mexico, ANEC Association (http://www.anec.org.mx). They organize seminars for farmers. They also aim at mitigating climate change impacts on agricultural products, e.g. assessing cold weather requirement/impact on wheat in Mexico. The Chapingo course programme offers two training opportunities on agricultural Meteorology namely:

(I) Irrigation (http://irrigacion.chapingo.mx?) with the subjects (http://irrigacion.chapingo.mx/planest.html) on Agricultural Meteorology in 2 semesters;

(II) Agricultural Ecology (http://agroecologia.chapingo.mx/) with the Universidad Autonoma Antonio Narro (http://www.uaaan.mx/v3/index.php/oferta). Ingeniero Agronomo en Irrigacion: Irrigation in the second semester.

5.4 RA V's Agro-meteorological Training Opportunities/Activities From Funded Projects: The Australian Society of Agricultural Meteorology has not been established at this point in time. There are no other registered National Agro-meteorological Societies in RA V and there are currently no funded projects in RA V.

6.0 Activities Carried Out Under TOR 5: Review the WMO Global Campus Initiative and make recommendations how to integrate the work of the G-CREAMS with this initiative.

While the WMO Global Campus initiative promotes closer collaboration between WMO's Regional Training Centres and Training Institutions of its Member-States towards meeting the growing demands for meteorological trainings required to develop and strengthen their respective meteorological capabilities and services, the Global Centres of Research and Excellence in Agro-Meteorology (G-CREAMs) provides cutting edge ideas and pioneering solutions to promote new and more advanced knowledge to a new generation of specialists, securing water and agriculture resources for future generations in an ecosystem approach under changing climate.

Given the agro-meteorological inclination of G-CREAM, CAgM desires to integrate the activities of G-CREAM with the WMO Global Campus initiatives. The followings are reports of progress made in this regard for the different WMO's Regional Associations (RAs) as put together by CAgM's Experts on "Capacity Building" under its Focus Area on "Capacity Development in Agricultural Meteorology":

6.1 RA I's Activities in Integrating works of G-CREAM with the WMO Global Campus initiatives: Although the WMO Global Campus Initiative is really a laudable project, there does not seem to be much of linkages between it and the GCREAMS over RA I. In addition, given the limited resources, very few countries in the region such as Mauritius; a Small Island Developing State can benefit in the areas of:

(1) Capacity building of the personnel of its Meteorological Services; and

(2) Exchange of expertise.

Recommendation: *it is therefore highly recommended that the focus of the framework should be on increasing awareness and funding opportunities, as well as achieving coordination and synergies across the* GCREAMS*, regional associations and co-sponsored programmes for supporting* WMO Global Campus *implementation at the regional level.*

6.2 RA III's Activities in Integrating works of G-CREAM with the WMO Global Campus initiatives: The G-CREAM in RAIII is based in São Paulo State Agriculture Department, Agronomic Institute. The emphasis is on Agro-meteorological forecast and warning system for quantifying the effects of extreme events such as drought on agriculture and crop development. The most important aspect refers to the evaluation and monitoring of drought and its agronomic and economic impacts. Agro-meteorological bulletins and advisories are used to provide support for mitigation and control of the drought. Meanwhile, there are other institutions and projects focused on the teaching of agro-meteorology.

Recommendations: WMO Global Campus Initiative should:

i) Promote the inclusion in the GCREAM of other institutions, like Agronomy Graduate School of Universities, that have a lot of prestigious courses available; or the National Institutes of Agricultural Technology;
ii) Make more visible the Training Activities of WMO Global Campus and GCREAM, for example, by putting relevant information on these trainings on NMHSs and Universities' web pages;
iii) Foster collaboration between WMO's Regional Training Centers, GCREAM and other Agro-meteorology Training Institutions;
iv) Encourage the personel of NMHSs to attend agro-meteorological training activities; and
v) Establish links among the entire agro-meteorological community to generate synergies in the development of training capacities.

6.3 RA IV's Activities in Integrating works of G-CREAM with the WMO Global Campus initiatives: For RA IV, G-CREAM is based in the USA at George Mason University, College of Science. Its main mandate/emphasis is on science and policy issues related to **sustainable use of water resources**, **and promoting secure agriculture systems**. Meanwhile, there are two WMO Regional Training Centres in RA IV namely:

i) Caribbean Institute for Meteorology and Hydrology (CIMH) and
ii) Universidad de Costa Rica (UCR).

Recommendations: The role of WMO Global Campus Initiative should therefore be to:

i) Promote extension of the trainings available at both the WMO Regional Training Centres and GCREAM to NMHSs' staff and to Universities that provide Agro-meteorology trainings;
ii) Place all the available trainings of WMO Global Campus on its website in order to facilitate their accessibility by NMHSs' staff (i.e. a one-stop training information centre);
iii) Foster collaboration between WMO's Regional Training Centres and GCREAM;
iv) Encourage exchange of knowledge and resources among WMO's Regional Training Centres, GCREAM and NMHSs;
v) Establish links between WMO's Regional Training Centres and GCREAM with Universities that provide training in agro-meteorology; and
vi) Invite high profile agro-meteorology professionals to deliver lectures or seminars at both WMO's Regional Training Centres and GCREAM or via online programmes.

6.4 RA V's Activities in Integrating works of G-CREAM with the WMO Global Campus initiatives: For RA V, G-CREAM is based in Australia at the International Centre for Applied Climate Sciences (ICACS) in the University of Southern Queensland. ICACS combines leading integrated systems research and development in climate and meteorological science with engineering, remote sensing and surveying, hydrological modelling, economic modelling, catchment-scale modelling and rural research to provide stronger predictive capacity for regional land and water planning and management. It also developed a web-based "discussion-support for climate information" to disseminate information on future predictions of climate change to regional farmers in India and throughout the world.

WMO has the following four Regional Training Centres (RTC) in RA V:

- Indonesia – Agency for Meteorology, Climatology and Geophysics (BMKG)
- Indonesia – Research Centre for Water Resources (RCWR)
- Philippines – Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) and
- Philippines – University of the Philippines (UP)

The Climate Field Schools (CFS) training course offered by Indonesian Agency for Meteorology, Climatology and Geophysics (BMKG) is an outstanding and successful programme. The hands-on training approach increases farmers' knowledge on the application of climate information in their decision-making. The user outreach approach of the CFS is in line with the aims of the Global Framework of Climate Services (GFCS), which seeks to bring together providers and users of climate services. Agriculture production and food security is one of the top priorities of the GFCS. These type of CFS training courses have been very successful in Indonesia.

The Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) is a Regional Training Centre (RTC) that offered two courses in 2017: "Meteorological Technicians Training Course (MTTC)" and "Meteorologists Training Course (MTC)". These courses focus mainly on climatology, hydrology, GIS, remote sensing etc. but both courses have limited agro-meteorology contents. The Department of Science and Technology (DOST) in consultation with government and private research and development institutions, the academia, industry and other concerned agencies in the Philippines prepared the Harmonized National R&D Agenda (HNRDA) 2017-2022 to ensure that results of science and technology endeavours are geared towards maximum economic and social benefits for the people. Section V of the HNRDA focuses on Disaster Risk Reduction and Climate Change Adaptation. PAGASA was one of the agencies evaluating the research priorities. One of the priorities is "Hazards, Vulnerability and Risk Assessment: Climate Risk for Agriculture" with a focus on:

A. Mitigation and Adaptation Studies (including protected agriculture, vertical agriculture);

B. Development of Smart Farming Approaches (including organic agriculture, integrated farming & ICT application) and other climate-resilient agricultural production technologies;

C. Development of Strategies/Decision Management Tools for Climate Change Resilient Environment (e.g. farm diversification); and

D. Enhancing Sustainable Development through landscape approach

Programs like the HNRDA 2017-2022 is providing central direction, leadership and coordination of the scientific and technological efforts in the country.

The University of the Philippines – Los Baños offers a Master of Science in Agro-meteorology: an interdisciplinary field, which relates the elements of atmospheric environment with agribusiness operations. It is designed to prepare students to deal with the weather-related problems affecting agricultural activity from the long-range planning to the daily operations. Graduates of the program will be qualified to work in the field of instructions, research and development in the academia or in the industry and consulting firms. Opportunities also exist in academic and research institutions, which include state colleges and universities, private universities and colleges, and government agencies (e.g. PAGASA, Philippine Rice Research Institute – (PHILRICE).

Unfortunately, no information was available for the Indonesian Research Centre for Water Resources (RCWR).

However, there are no active collaborative activities between the mentioned institutions above and the G-CREAM based at ICACS.

Recommendations: The role of the WMO Global Campus Initiative should be:

a) To promote and extend training opportunities available at G-CREAM and WMO Regional Training Centres to National Meteorological and Hydrological Services (NMHS) and to universities who offer agro-meteorology courses;
b) To set up a website where all training courses, workshops etc. are listed with contact details and are updated regularly; and
c) To facilitate collaboration and encourage knowledge exchange among WMO Regional Training Centres, G-CREAM and universities that provide training in agro-meteorology.

7.0 Conclusion: The Expert Team members on Capacity Building have indeed put in a great deal of efforts in bringing up the above extensive list of agro-meteorological training programmes, including funding relevant links and funding partners.

The Team have also made very useful recommendations on how to make the best use of the training opportunities in all the regions, especially through closer collaborations between WMO and the relevant universities/the funding institutions.

These will no doubt contribute to realization of the expected deliverables such as development of agro-meteorological training modules, better communication strategies and improved interaction with relevant agro-allied institutions in the respective regions of WMO.