

FORMULARIO INFORME TECNICO

GIRAS DE INNOVACIÓN 2016

Nombre de la gira de innovación

Sistema Biodinámico de Producción para Berries y Cerezo desarrollado en el marco de un Modelo Comercial de Exportación de Comercio Justo (*Fairtrade*) en el centro norte de Italia.

Código FIA

GIT-2016-0343

Fecha de realización de la gira

Fecha de Inicio: 25/06/2016; Fecha de Término: 01/07/2016

Ejecutor

EMPRESA DE CAPACITACION TECNOLÓGICA AGRÍCOLA LTDA. (Capacitec LTDA.)

Coordinador

Dra. Alejandra Ribera Fonseca

Departamento de Producción Agropecuaria,
Facultad de Ciencias Agropecuarias y Forestales,
Universidad de La Frontera,
Temuco, Chile.

País (es) visitado (s)

Italia (Zona Centro-Norte)

Firma del coordinador

OFICINA DE PARTES 2 FIA	
RECEPCIONADO	
Fecha	27 SEP 2016
Hora	13:40
Nº Ingreso	32810

Instrucciones:

- La información presentada en el informe técnico debe estar directamente vinculada a la información presentada en el informe financiero, y ser totalmente consistente con ella.
- El informe técnico debe incluir información en todas sus secciones, incluidos los anexos
- Los informes deben ser presentados en versión digital y en papel (dos copias), en la fecha indicada como plazo de entrega en el contrato firmado entre el ejecutor y FIA

1. Identificación de los participantes de la gira de innovación

Nombre y apellido		Entidad donde trabaja	Profesión, especialización	Correo electrónico	Teléfono	Dirección
1	Alejandra Ribera Fonseca	Universidad de La Frontera	Ingeniero Agrónomo y Doctor en Ciencias de Recursos Naturales. Especialidad: Fisiología y Sustentabilidad de Especies Frutales.			
2	Rodrigo Neculman Cerda	Capacitec Ltda.	Ingeniero Agrónomo y Doctor en Ciencias de Recursos Naturales. Especialización: Producción Limpia de Especies Hortofrutícolas y Manejo de Suelo.			
3	Pablo Aedo Mora	Agrolim Ltda.	Asesor Técnico de Hortalizas y Berries			
4	Marcelo Luna Angulo	Capacitec Ltda.	Médico Veterinario. Especialización: Producción Limpia de Especies Hortofrutícolas. Coordinador PDTN – InnovaChile de CORFO.			
5	Pedro Burgos Garcés	Persona Natural (Predio particular)	Productor Hortofrutícola (Arándanos)			
6	Juan Pablo Álvarez Doyharcabal	Persona Natural (Predio particular)	Productor y Viverista de Cerezo para Exportación.			
7	Cristian Mieville Bernal	Persona Natural (Predio particular)	Perito Agrícola. Productor Frutícola (Arándano y Avellano Europeo).			

2. Itinerario realizado en la gira de innovación

Entidad (institución/empresa/ productor)	Ciudad y país	Describe las actividades realizadas	Nombre y cargo de la persona con quien se realizó la actividad en la entidad visitada	Temática tratada en la actividad	Fecha (día/mes/ año)
OrtoFruit Italia: Area tecnica: Oratcchi e piccoli frutti http://www.ortofruititalia.org	Saluzzo, Región de Piamonte, Italia.	Visita a huertos de frambuesos cultivados bajo techos y con uso de mulch plástico. Visita a huerto orgánico de arándano. Visita a huertos de arándanos orgánicos en conversión a producción biodinámica. Visita al área de packing de la empresa y charla en terreno respecto a comercialización de fruta.	Ingenieros Agrónomos: Claudio Baudino y Ezio Giraudo Cargos: Especialistas encargados del área de producción hortícola y berries.	Importancia de la calidad fitosanitaria en la implementación de prácticas de producción sustentable de especies frutícolas y estrategias de control fitosanitario en huertos orgánicos y biodinámicos Estrategias de fertilización en huertos orgánicos y biodinámicos. Estrategias de comercialización y packing para diferentes especies de berries	27/06/2016
Fondazione Edmund Mach http://www.fmach.it/	San Michelle all' Adice, Trento, Region del Trentino, Italia	Capacitación en terreno respecto a la elaboración de compost biodinámico Capacitación en terreno respecto a aspectos y fundamentos teóricos de la agricultura biodinámica (uso de biopreparados) Visita a huertos de cerezos (uso de portainjertos, sistemas de conducción, calidad y comercialización de fruta, uso de cubiertas para protección de lluvia, heladas y ataque de insectos) Visita a sistemas hidropónicos de producción de frutilla bajo cubiertas.	Ingenieros Agrónomos: Enzo Mescalchin (viñedos), Sergio Franchini (cerezos) y Tommaso Pantezzi (berries) Cargos: Especialistas del Centro de Transferencia Tecnológica.	Elaboración de compost biodinámico Fundamentos de la Producción Biodinámica Uso de bio- preparados en la producción biodinámica Importancia del uso de cubiertas para la protección de lluvias, insectos y granizos en huertos frutícolas Portainjertos y poda de producción en cerezos	28/06/2016
Dipartimento di Scienze Agrarie (DIPSA), Università di Bologna. http://www.scienzeagrarie.unibo.it/it	Bologna, Region de Emilia- Romagna, Italia.	Visita a salas de clases, laboratorios, invernaderos del Dipartimento di Scienze Agrarie (DIPSA), Università di Bologna.	Investigadores y/o Académicos: Dr. Adamo D. Rombolá	Diseño de estrategias de producción biodinámica para especies frutales.	29/06/2016

Dipartimento di Scienze Agrarie (DIPSA), Università di Bologna. http://www.scienzeagrarie.unibo.it/it		Taller grupal para el diseño de estrategias de manejo biodinámico aplicables a huertos de cerezo y arándano.	Dr. Maurizio Quartieri Dra. Ana María Bregoli	Importancia del uso de intercultivos y cultivos sobre la hilera en la fertilización de huertos sustentables.	29/06/2016
Centro Didattico Sperimentale di Cadriano, Università di Bologna. http://www.aziendaagrarie.unibo.it/it/unita-aziendali/centro-didattico-sperimentale-di-cadriano	Cadriano, Bologna, Region de Emilia-Romagna, Italia	Visita a huertos de cerezo dulce (variedades serie Sweet): sistemas de conducción, manejo de poda, uso de cubiertas. Discusión respecto a las posibilidades de aplicar estrategias de producción biodinámica de cerezos: recomendación de cultivares. Visita a huertos frutales que utilizan postes vivos (árboles) como estructuras de sostén para el sistema de conducción.	Ingeniero agrónomo e investigador especialista en cerezos: Dr. Michelangelo Grandi	Uso de cubiertas en huertos de cerezos Poda de producción de cerezos Uso de Portainjertos en cerezos Discusión respecto de variedades de cerezo de la Serie Sweet, recomendables para la region de la Araucanía.	29/06/2016
Vigneto San Vito: Orsi, www.vignetosanvito.it	Monteveglia, Colli Bolognese, Bologna, Region de Emilia-Romagna, Italia.	Visita a viñedos biodinámicos. Visita a bodega, capacitación respecto al proceso de vinificación natural, asociado a la producción de vinos biodinámicos	Enólogo: Federico Orsi	Estrategias de fertilización y manejo fitosanitario en viñedos biodinámicos Enología biodinámica	30/06/2016
Consorzio della Ciliegia della Susina e della Frutta tipica di Vignola	Vignola, Region de Emilia-Romagna Italia	Visita a dependencias del Consorzio Capacitación respecto a la generación de la marca "Vignola" (ej. Cerezas), y la importancia de la identidad geográfica en la comercialización de fruta. Visitas a huertos de cerezos de la zona: variedades, sistemas de conducción, uso de portainjertos, uso de cubiertas, sistemas mecanizados de cosecha.	Ingeniero Agrónomo: Walter Monari	Aspectos asociados a la comercialización, valor agregado, envases, importancia de la marca y proceso de venta de fruta fresca. Concepto de Identificación geográfica y denominación de origen de productos agrícolas	30/06/2016
Azienda agricola "TERRE NALDI": Polo tecnologico di Tebano	Faenza Ravenna, Región de Emilia-Romagna, Italia	Visita a dependencias (laboratorios, huertos experimentales, otros) del Polo Vitivinícola de Tebano.	Ingeniero Agrónomo: Dr. Adamo Rombolà Enólogo Giordano Zinzani (Presidente del Consorzio del Vino de Romagna -Italia)	Establecimiento y funcionamiento de cooperativas Importancia de la denominación de origen en la comercialización de vino.	01/07/2016

Azienda agricola "TERRE NALDI": Polo tecnologico di Tebano	Faenza Ravenna, Región de Emilia- Romagna, Italia	Seminario respecto a la experiencia italiana del uso del sistema de cooperativas para la comercialización de fruta en Italia. Visita a viñedos orgánicos y Biodinámicos. Capacitación en terreno respecto al diseño de estrategias de manejo biodinámico aplicadas en viñedos, factibles de aplicar en huertos de cerezo y arándano en el sur de Chile. Cata de vinos biodinámicos y orgánicos.	Enóloga Giuseppina Parpinello (académico e investigador de Unibo que participa como investigador en Polo di Tebano).	Diseño de estrategias de producción biodinámicas en viñedos Diferencias en las propiedades enológicas de vinos Biodinámicos & Orgánicos	01/07/2016
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2.1 Indicar si hubo cambios respecto al itinerario original

No se realizaron grandes cambios de itinerario respecto de la postulación original. Sin embargo, de acuerdo a la programación inicial, la Gira debía iniciar el 25 de Junio pero inició el 27 de junio, debido a que la actividad que se había programado para el 25 de junio con el profesor Rombolá para inicio formal de la gira (Día sábado), fue suspendida por problemas personales de última hora del anfitrión. Por otra parte, respecto a los objetivos planteados originalmente, la captura de información respecto a la comercialización de productos agrícolas bajo el sello de Comercio Justo se vio dificultada, ya que la persona encargada de recibirnos en Italia para discutir este tema (Dr. Cesare Zanasi, Unibo, Italia) tuvo que viajar en forma urgente por trámites personales. Finalmente, dicha información fue obtenida mediante consultas realizadas durante las diferentes visitas. Además, el Profesor Adamo D. Rombolá (DIPSA, Unibo, Italia), compartió un link (<http://www.fairtrade.net/es.html>) y un texto respecto al tema (ver anexos).

3. Indicar el problema y/o oportunidad planteado inicialmente en la propuesta

La Universidad de Bolonia (UNIBO, Italia) actualmente se encuentra dentro del grupo de las "World Top 500" Universidades, siendo documentada como una de las Instituciones de Educación Superior más antiguas de Europa. Esta Universidad posee un destacado reconocimiento internacional en el área de Ciencia y Tecnología Agrícola aplicada a vides y especies de frutales mayores y menores. En este contexto, el Dr. Adamo Doménico Rombolà, quien se desempeña como investigador y académico en el Departamento de Ciencias Agrarias (DIPSA) de UNIBO cuenta con un alto *expertise* en Fisiología de Especies Frutales y en la implementación de Sistemas Agrícolas Altamente Sostenibles, incluyendo Sistemas de Producción Biodinámico de Especies Frutales y Vides.

A la Fecha, los estudios del Grupo de Investigación del Dr. Rombolá han demostrado que es posible obtener plantas equilibradas y saludables, y frutas y vinos de alta calidad, mediante la implementación de estrategias de producción biodinámicas, tales como: el uso de intercultivos (entre-hileras y sobre-hileras) para mejorar la fertilización y eficiencia de uso del agua en el huerto, la aplicación de bio-preparados biodinámicos, el uso de moléculas inorgánicas (en base a cobre y azufre) para el control de enfermedades y plagas, y la fertilización natural a través del manejo de residuos de poda y cubiertas verdes, entre otras. De acuerdo al profesor Rombolá, estas estrategias de producción biodinámica han derivado, entre otros, en una mejora de la fertilidad del suelo y de la resiliencia de las plantas y el agroecosistema frente a diferentes condiciones de estrés biótico y abiótico, junto con generar un aumento significativo de las propiedades nutricionales y funcionales e inocuidad de los frutos.

La delegación de esta gira, tanto productores como profesionales; están participando en proyectos de vanguardia e innovación en el ámbito de la producción limpia hortofrutícola. Así, la ejecución de la presente Gira de Innovación vendrá a ampliar el bagaje de los profesionales que dirigen, asesoran y ejecutan dichos proyectos, y que en conjunto con los agricultores, les permitirá: Conocer experiencias de campo respecto a la implementación de estrategias de producción biodinámicas en especies frutales mayores y menores, y conocer experiencias asociativas de comercialización de fruta fresca a través de cooperativas orientadas al mercado interno y exportación y que están trabajando bajo sistemas de comercio justo (Fairtrade).

Si bien se conoce de la existencia de experiencias de producción biodinámica en viñas y manzano en el país; no hay experiencia de la implementación de este modelo de producción sustentable en arándano, cerezo y frambueso, menos en la Región de La Araucanía. Dicha situación se convierte en una oportunidad, toda vez que existe un creciente interés de productores locales, pequeños y medianos, por conocer e implementar nuevos modelos sustentables de producción que agreguen valor a su oferta de fruta y que permitan sumar además un sistema novedoso de comercialización que beneficien de manera más justa toda la cadena productiva mediante el Fairtrade.

Esta Gira de Innovación sentará el precedente además, para el desarrollo de un nuevo Proyecto de Difusión y Transferencia (PDT) que se ejecutará a través de CORFO en Sistemas Sustentables de Producción de Frutales con fruticultores de la Araucanía durante el segundo semestre de este año y que está siendo gestionado y será ejecutado por Capacitec Ltda.

4. Indicar el objetivo de la gira de innovación

El objetivo de esta Gira de Innovación fue capturar tecnologías y estrategias para la producción biodinámica de especies frutícolas de importancia económica para la Región de La Araucanía, tales como cerezo, arándano y frambueso. Por otra parte el desarrollo de la presente Gira se orienta a capturar información respecto a la obtención y comercialización de productos hortofrutícolas bajo la categoría Fairtrade (Comercio Justo), apuntando a aumentar en forma significativa el valor de exportación de los mismos en el mercado internacional. Así, el desarrollo de esta Gira de Innovación sustentará y sentará las bases para la postulación futura a proyectos I+D+i orientados a mejorar la capacidad y calidad productiva de los fruticultores (pequeños y medianos) de la región.

5. Describa clara y detalladamente la o las soluciones innovadoras encontradas en la gira

- ✓ Elaboración de compost biodinámico y su recomendación de uso en huertos frutícolas y viñedos biodinámicos
- ✓ Implementación de intercultivos (sobre-hilera e inter-hilera) en huertos frutícolas y viñedos biodinámicos y orgánicos, para mejorar la eficiencia de uso de nutrientes y agua.
- ✓ Protocolos de manejo fitosanitario en huertos frutícolas y viñedos biodinámicos
- ✓ Aplicación de preparados biodinámicos (biopreparados) y su efecto en el crecimiento y sanidad de especies frutales.
- ✓ Conocer experiencias asociativas de comercialización de fruta fresca a través de cooperativas orientadas al mercado interno y de exportación.
- ✓ Manejo de poda, uso de porta-injertos y uso de cubiertas en huertos cerezo.
- ✓ Uso de mulch plástico como estrategia para el control de malezas en huertos orgánicos y biodinámicos de berries.

6. Indique la factibilidad de implementar en el país la o las soluciones innovadoras encontradas en la gira

Capacitec Ltda. desarrollará un Programa de Difusión y Transferencia (PDT) de CORFO en tecnologías sustentables de producción de frutales a partir del segundo semestre de este año, donde esta misión tecnológica permitirá dar pie al conocimiento y prospección de uno de los sistemas menos difundido en nuestra región, como es el biodinámico, que buscará junto a otros sistemas como el orgánico, poder incrementar la oferta de fruta limpia para la exportación trabajada bajo un modelo de Comercio Justo que haga coherente el desarrollo del circuito completo: "Producción sustentable y Comercio Justo".

Actualmente Capacitec Ltda., atiende a un universo de 300 agricultores del segmento de mayor desarrollo tecnológico de INDAP a través del programa de Servicio de Asesoría Técnica (SAT) en la región de La Araucanía, con los cuales está trabajando y difundiendo la batería de tecnologías limpias que ha logrado capitalizar en los programas CORFO y FIA anteriores fundamentalmente en el rubro de hortalizas y que está proyectando hacia los productores frutícolas en la actualidad donde esta gira de innovación marca el principio de esta intervención en el rubro.

Algunas de las técnicas de producción biodinámica capturadas durante la Gira, actualmente están siendo aplicadas por los productores participantes. Además, varias de las prácticas capturadas fueron de gran interés para los productores que asistieron a las charlas de difusión.

7. Indique y describa los contactos generados en el marco de la realización de la gira de innovación

Nombre del contacto	Institución a la que pertenece	Descripción de su trabajo en la institución	Teléfono	Correo electrónico	Dirección
Dr. Adamo D. Rombolà	Departamento de Ciencias Agrarias (DIPSA), Universidad de Bologna, Bologna, Italia.	Académico e Investigador. Grupo de Investigación: Plant Stress Physiology & Highly Sustainable Viticultural Systems.			
Claudio Baudino	Ortofruit Italia, Saluzzo, Italia.	Encargado del área técnica de producción hortícola y pequeños frutos (berries)	-----		
Ezio Giraudo	Ortofruit Italia, Saluzzo, Italia.	Encargado del área técnica de producción hortícola y pequeños frutos (berries)			
Enzo Mescalchin	Fondazione Edmund Mach di San Michele all'Adige	Investigador de la Unidad de Agricultura Biológica, Centro de Transferencia Tecnológica.			
Sergio Franchini	Fondazione Edmund Mach di San Michele all'Adige	Investigador de la Unidad de Fruticultura, Pequeños frutos (berries) y Frigo-conservación Especialidad: Cerezos			
Tommaso Pantezzi	Fondazione Edmund Mach di San Michele all'Adige	Encargado de la Unidad de Fruticultura, Pequeños frutos (berries) y Frigo-conservación, Centro de Transferencia Tecnológica.	-----		

Maurizio Quartieri	Universidad de Bologna, Bologna, Italia.	Académico e Investigador del Departamento de Ciencias de árboles frutales y plantas leñosas.			
Ana Maria Bregoli	Departamento de Ciencias Agrarias (DIPSA), Universidad de Bologna, Bologna, Italia.	Investigador			
Walter Monari	Consorzio della Ciliegia della Susina e della Frutta tipica di Vignola	Encargado			
Federico Orsi	Vigneto San Vito	Dueño y Enólogo	-----		
Michelangelo Grandi	Laboratori di tecnologia (Cadriano), Centro Experimental Cadriano, y Dipartimento Scienze Agrarie, Universidad de Bologna.	Investigador. Especialidad: Mejoramiento Genético y Manejo de Cerezo Dulce.			
Giuseppina Parpinello	Dipartimento di Scienze e Tecnologie Agro-Alimentari, Universidad de Bologna	Académico e Investigador. Especialidad: Enología.			
Giordano Zinzani	Consorzio del Vino de Romagna (CAVIRO Soc. Coop. Agricola.)	Enólogo, Presidente.	-----		

8. Indique posibles ideas de proyectos de innovación que surgieron de la realización de la gira

- Desarrollo de proyectos de producción biodinámica de arándano en La Araucanía.
- Manejo de fertilización y agua en huertos de cerezo de la región mediante el uso de intercultivos.
- Incorporación de nuevas variedades tardías de cerezo de la serie Sweet en nuestra región.
- Importación y prueba de variedades de cepas italianas de vid para adaptación en el sur de Chile.
- Desarrollo de vitivinicultura biodinámica en el sur de Chile.

9. Resultados obtenidos

Resultados esperados inicialmente	Resultados alcanzados
Conocer experiencias de campo respecto a la implementación de estrategias de producción biodinámicas en especies frutales mayores y menores.	Se realizaron diversas visitas a huertos biodinámicos, en las cuales se tuvo la oportunidad de obtener información práctica y teórica de primera calidad, generada y/o monitoreada por investigadores de alto renombre en Italia. En este gira investigadores, empresarios y productores de la región de La Araucanía tuvieron la oportunidad de conocer de cerca los primeros hallazgos científicos respecto a los reales impactos positivos de la producción biodinámica de especies frutales, respecto a los sistemas orgánicos y/o convencionales de producción.
Conocer experiencias asociativas de comercialización de fruta fresca a través de cooperativas orientadas al mercado interno y exportación y que están trabajando bajo sistemas de comercio justo (Fairtrade).	Durante la realización de esta gira se visitaron varias experiencias de comercialización de fruta fresca, en las cuales se pudo obtener información respecto a las claves del éxito de las cooperativas y el comercio de productos agrícolas bajo el sello de comercio justo, entre otras categorías.

Del desarrollo de la presente Gira, se pudieron recabar los siguientes aspectos principales:

- ✓ En Chile existe una deuda pendiente respecto a la producción orgánica y biodinámica de especies frutales. Es necesario avanzar. En Italia la producción biodinámica aún es incipiente.
- ✓ Los predios visitados concuerdan en que no se detectan reducciones de la productividad en huertos biodinámicos, mientras la calidad de la fruta se mantiene o aumenta.
- ✓ La producción biodinámica de berries y cerezo debe considerar como aspectos clave: calidad del suelo, sanidad de la planta, selección de variedades adaptadas y asociatividad.
- ✓ El alto requerimiento de mano de obra y dificultad en la obtención de bio-preparados (preparados por los mismos productores), constituyen dos de las principales limitantes para la producción biodinámica de frutas.
- ✓ La destacable condición fitosanitaria de Chile permite considerar a la producción biodinámica como una oportunidad factible.
- ✓ Plantas biodinámicas exhiben mayores niveles de resistencia a condiciones de estrés y una mayor eficiencia en el uso de recursos.
- ✓ Hoy en día existe la posibilidad de comparar los biopreparados (preparados biodinámicos) a un relativo bajo costo (compra directa mediante páginas webs), lo cual facilita la aplicación de las estrategias biodinámicas.
- ✓ El uso de cultivos sobre- y entre-hileras representa una interesante alternativa para mejorar la fertilidad de suelo, reducir los riesgos de problemas fitosanitarios, mejorar la eficiencia de uso del agua de riego e incrementar la rentabilidad del productor.
- ✓ El éxito de las cooperativas y asociatividad entre productores parece responder a un aspecto cultural.
- ✓ El ente de certificación de productos agrícolas biodinámicos es privado, lo cual dificulta el proceso y lo vuelve menos atractivo para el productor. Muchos producen biodinámico pero certifican como orgánicos.
- ✓ En Europa existe una demanda no cubierta por berries y cerezos chilenos, la cual a la fecha no ha sido cubierta.
- ✓ La inversión en nuevas formas de presentación, envases y calificación de berries y cerezo (denominación de origen, identificación geográfica, otros) es un desafío que se debe abordar.
- ✓ El apoyo de instituciones gubernamentales es fundamental para el desarrollo de estas iniciativas

10. Actividades de difusión de la gira de innovación

Fecha (día/mes/año)	Tipo de actividad (charla, taller de discusión de resultados y/o publicación)	Tipo de participantes (indicar hacia quien está orientada la actividad)	N° de participantes
29/07/2016	Charla de Difusión, Salón Auditorium, Facultad de Ciencias Agropecuarias y Forestales, Universidad de La Frontera, Temuco, Chile.	Alumnos (as) y Académicos (os) de la Universidad y Productores Hortofrutícolas de la región. Expositor: Alejandra Ribera	13
03/08/2016	Charla de Difusión, Salón Auditorium, Universidad de La Frontera (Sede Angol), Angol, Chile.	Productores y Empresarios del Rubro Hortofrutícolas de la región. Expositor: Alejandra Ribera	17
05/08/2016	Charla de Difusión, Centro Cultural de Loncoche, Loncoche, Chile.	Productores y Empresarios del Rubro Hortofrutícolas de la región. Expositor: Pablo Aedo	26
10/08/2016	Charla de Difusión, Sede Regional Villarrica, Pontificia Universidad Católica, Villarrica, Chile.	Productores y Empresarios del Rubro Hortofrutícolas de la región. Expositor: Alejandra Ribera	14

11. Indique cualquier inconveniente que se haya presentado en el marco de la realización de la gira de innovación

No se presentaron mayores inconvenientes durante el desarrollo de esta Gira.

ENCUESTAS DE SATISFACCION

Encuesta de satisfacción de participantes de giras para la innovación

Nombre de la Entidad Ejecutora:	CAPACITEC LTDA.		
Dirección:			
Teléfono:			
Coordinador (a):	ALEJANDRA RIBERA FONSECA		

Valore de 1 a 5 cada uno de los aspectos referentes al encuentro, teniendo en cuenta que la puntuación más negativa es 1 y la más positiva es 5.

	1	2	3	4	5
Se ha conseguido el objetivo del gira					X
Nivel de conocimientos adquiridos					X
Aplicación del conocimiento de nuevas tecnologías posibles de incorporar en su quehacer				X	
Estoy satisfecho (a) con la realización de la gira					X
Los lugares de realización de la gira, fueron los adecuados.					X
Los contactos visitados, a través de la gira, fueron un aporte al objetivo de la gira.					X
Organización global de la gira.					X

Comentarios adicionales:

La realización de esta Gira fue una experiencia exitosa. Durante su ejecución, fue posible conocer e interactuar con investigadores connotados y reconocidos internacionalmente con experiencia en producción biodinámica, algunos de los cuales han publicado los primeros hallazgos científicos respecto a los impactos positivos de la aplicación de estrategias biodinámicas para la producción agrícola. Hemos logrado establecer una destacable red de contactos en la temática. Además, tuvimos la posibilidad de visitar una importante cantidad de huertos frutales y viñedos en los cuales se están aplicando dichas prácticas, logrando así aumentar nuestros conocimientos, tanto teóricos como prácticos, respecto este sistema de producción. Como se mencionó en las conclusiones de la Charla de Difusión, en Chile existe una deuda pendiente respecto a la producción orgánica y biodinámica de especies frutales y es necesario avanzar, sin embargo en Europa la producción biodinámica aún es incipiente y podemos avanzar en forma simultánea. La producción biodinámica de berries y cerezo debe considerar como aspectos clave la calidad del suelo, sanidad de la planta, selección de variedades adaptadas y la asociatividad. Todos los participantes concordamos en que las prácticas de producción biodinámicas pueden ser consideradas no sólo como técnicas eficientes y limpias de producción de fruta con un mayor precio de venta, sino que también como estrategias para mejorar la sustentabilidad y resiliencia de cualquier sistema agrícola.

Encuesta de satisfacción de participantes de giras para la innovación

Nombre de la Entidad Ejecutora:	CAPACITEC LTDA.		
Dirección:			
Teléfono:			
Coordinadora:	ALEJANDRA RIBERA FONSECA		

Valore de 1 a 5 cada uno de los aspectos referentes al encuentro, teniendo en cuenta que la puntuación más negativa es 1 y la más positiva es 5.

	1	2	3	4	5
Se ha conseguido el objetivo del gira					x
Nivel de conocimientos adquiridos					x
Aplicación del conocimiento de nuevas tecnologías posibles de incorporar en su quehacer				x	
Estoy satisfecho (a) con la realización de la gira					x
Los lugares de realización de la gira, fueron los adecuados.				x	
Los contactos visitados, a través de la gira, fueron un aporte al objetivo de la gira.				x	
Organización global de la gira.					x

Comentarios adicionales:

Escriba aquí:

De acuerdo a mi experiencia fue una muy buena gira por el nivel de excelencia de los investigadores que nos recibieron, y adquirimos conocimiento en tecnologías innovadoras, de punta en agricultura sustentable aplicable en nuestra fruticultura.

Destacar la coordinación de la docente de la Facultad de Agronomía de la UFRO. Alejandra Ribera.

Encuesta de satisfacción de participantes de giras para la innovación

Nombre de la Entidad Ejecutora:	CAPACITEC LTDA.		
Dirección:			
Teléfono:			
Coordinadora:	ALEJANDRA RIBERA FONSECA		

Valore de 1 a 5 cada uno de los aspectos referentes al encuentro, teniendo en cuenta que la puntuación más negativa es 1 y la más positiva es 5.

	1	2	3	4	5
Se ha conseguido el objetivo del gira					X
Nivel de conocimientos adquiridos					X
Aplicación del conocimiento de nuevas tecnologías posibles de incorporar en su quehacer					X
Estoy satisfecho (a) con la realización de la gira					X
Los lugares de realización de la gira, fueron los adecuados.					X
Los contactos visitados, a través de la gira, fueron un aporte al objetivo de la gira.					X
Organización global de la gira.					X

Comentarios adicionales:

Escriba aquí: Tras la participación en diferentes giras tecnológicas; mi opinión es que ésta, tanto por su organización, el alto nivel de los contactos, profesionales y lugares visitados, además de una excelente convivencia con el grupo participante, ha sido una de las mejores en las que he participado, amén de poder vislumbrar el desarrollo de distintos potenciales proyectos en la dinámica de Producción Limpia y diversificación agrícola de nuestra región de La Araucanía. En síntesis, una excelente gira de innovación.

Encuesta de satisfacción de participantes de giras para la innovación

Nombre de la Entidad Ejecutora:	CAPACITEC LTDA.		
Dirección:			
Teléfono:			
Coordinadora:	ALEJANDRA RIBERA FONSECA		

Valore de 1 a 5 cada uno de los aspectos referentes al encuentro, teniendo en cuenta que la puntuación más negativa es 1 y la más positiva es 5.

	1	2	3	4	5
Se ha conseguido el objetivo del gira					X
Nivel de conocimientos adquiridos					X
Aplicación del conocimiento de nuevas tecnologías posibles de incorporar en su quehacer				X	
Estoy satisfecho (a) con la realización de la gira				X	
Los lugares de realización de la gira, fueron los adecuados.				X	
Los contactos visitados, a través de la gira, fueron un aporte al objetivo de la gira.					X
Organización global de la gira.				X	

Comentarios adicionales:

La gira realizada fue totalmente exitosa, bien organizada y los lugares visitados fueron los adecuados. Sin embargo, la adopción de estos nuevos sistemas de producción, deben ser mayormente estudiados y desarrollados desde la investigación e innovación (proyectos I+D+i), para que en un mediano plazo, puedan incorporarse como una alternativa real y viable, en términos comerciales, para los productores hortofrutícolas.

Encuesta de satisfacción de participantes de giras para la innovación

Nombre de la Entidad Ejecutora:	CAPACITEC LTDA.		
Dirección:			
Teléfono:			
Coordinadora:	ALEJANDRA RIBERA FONSECA		

Valore de 1 a 5 cada uno de los aspectos referentes al encuentro, teniendo en cuenta que la puntuación más negativa es 1 y la más positiva es 5.

	1	2	3	4	5
Se ha conseguido el objetivo del gira					X
Nivel de conocimientos adquiridos					X
Aplicación del conocimiento de nuevas tecnologías posibles de incorporar en su quehacer					X
Estoy satisfecho (a) con la realización de la gira					X
Los lugares de realización de la gira, fueron los adecuados.					X
Los contactos visitados, a través de la gira, fueron un aporte al objetivo de la gira.					X
Organización global de la gira.					X

Comentarios adicionales:

Escriba aquí: Mi participación en la gira me permitió ver temas de vanguardia en la producción limpia de arándanos como una oportunidad para mejorar el trabajo en mi huerto y como una excelente oportunidad de negocio. Las tecnologías revisadas en cerezo en Italia, además me permitieron ver la oportunidad de poder incorporarme en el rubro, cosa que al regreso me hizo tomar la decisión de iniciar una nueva plantación con esta especie que hoy ya inicié y está en progreso. La organización de la gira, la calidad de las visitas y la armonía del grupo fueron a mi parecer lo mejor de la misión.

Encuesta de satisfacción de participantes de giras para la innovación

Nombre de la Entidad Ejecutora:	CAPACITEC LTDA.		
Dirección:			
Teléfono:			
Coordinadora:	ALEJANDRA RIBERA FONSECA		

Valore de 1 a 5 cada uno de los aspectos referentes al encuentro, teniendo en cuenta que la puntuación más negativa es 1 y la más positiva es 5.

	1	2	3	4	5
Se ha conseguido el objetivo del gira					X
Nivel de conocimientos adquiridos					X
Aplicación del conocimiento de nuevas tecnologías posibles de incorporar en su quehacer					X
Estoy satisfecho (a) con la realización de la gira					X
Los lugares de realización de la gira, fueron los adecuados.					X
Los contactos visitados, a través de la gira, fueron un aporte al objetivo de la gira.					X
Organización global de la gira.					X

Comentarios adicionales:

Escriba aquí: DAR GRACIAS A LOS ENCARGADOS DE LA GIRA YA QUE LOS CONOCIMIENTRO ADQUIRIDOS SERAN DE GRAN IMPORTANCIA PARA LA PRODUCCION DE MI HUERTO DE ARANDANOS . EXISTEN OTRAS MANERAS DE PRODUCIR Y LA QUE NOS MOSTRARON ES UNA INTERESANTE ALTERNATIVA. AL RESPECTO ESTAMOS TRABAJANDO ALGUNAS MECANISMOS DE LA PRODUCCION BIODINAMICA. ESTAMOS SEGUROS QUE MEJORAREMOS MUCHO APLICANDO ESTAS TECNICAS.

AGRADECIMIENTOS ESPECIALES A: SR. PABLO AEDO

SR MARCELO LUNA

SRTA. ALEJANDRA RIVERA

Encuesta de satisfacción de participantes de giras para la innovación

Nombre de la Entidad Ejecutora:	CAPACITEC LTDA.		
Dirección:			
Teléfono:	Mail:		
Coordinadora:	ALEJANDRA RIBERA FONSECA		

Valore de 1 a 5 cada uno de los aspectos referentes al encuentro, teniendo en cuenta que la puntuación más negativa es 1 y la más positiva es 5.

	1	2	3	4	5
Se ha conseguido el objetivo del gira					✓
Nivel de conocimientos adquiridos					✓
Aplicación del conocimiento de nuevas tecnologías posibles de incorporar en su quehacer					✓
Estoy satisfecho (a) con la realización de la gira					✓
Los lugares de realización de la gira, fueron los adecuados.					✓
Los contactos visitados, a través de la gira, fueron un aporte al objetivo de la gira.					✓
Organización global de la gira.					✓

Comentarios adicionales:

Escriba aquí:

PARA MI EN lo personal, fue una experiencia completa, ver el como funciona la producción de mi mismo rubro al otro lado del mundo, bajo el enfoque organico y biodynamic fue sencillamente una de las mejores oportunidades que se me han brindado, No solo por el hecho de vivir la experiencia in situ, sino por poder comprender que es perfectamente aplicable en nuestro país bajo nuestra realidad.

ANEXOS

- 1) Anexo 1: Documentos técnicos recopilados en la gira de innovación
- 2) Anexo 2: Material audiovisual recopilado en la gira de innovación
- 3) Anexo 3: Lista de participantes de la actividad de difusión, indicando nombre, apellido, entidad donde trabaja, teléfono, correo electrónico y dirección.
- 4) Anexo 4: Material entregado en las actividades de difusión

Anexo 1:

Documentos técnicos recopilados en la gira de
innovación

**Relationship between ethics and Fair Trade supply chain
organisation and performance: the case of Italian
Alternative Trade Organisations (ATO's)**

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'International Marketing and International Trade of Quality Food Products',
Bologna, Italy, March 8-10, 2007**

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Relationship between ethics and Fair Trade supply chain organisation and performance: the case of Italian Alternative Trade Organisations (ATO's)¹

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Summary

Fair Trade related import from developing countries is quickly growing although it still represents a small share of the total import. Its influence on the development of rural areas in developing countries is related to both quantitative growth and the respect of its ethical code. Large food multi-national companies are increasingly interested in Fair Trade; part of the Fair Trade movement considers the risk of a related loss in the products' identity; others consider the refusal of a more "professional" approach to Fair Trade management as a constraint to its growth. This debate is particularly felt in Italy. The goal of this paper is to evaluate how the most important Italian Fair Trade importers (ATO's) business models influenced their growth strategies; transaction costs analysis and logistics performance indicators were adopted to measure the supply chain coordination efficiency and performance. The results showed that the ATO's growth strategies, and logistics performances, seemed more influenced by their value propositions, than the lack of managerial skill.

KEYWORDS: Fair Trade, Logistics, Alternative Trade Organisations

1. Introduction

The introduction of Fair Trade in the agricultural products international trade can positively influence the developing countries socio-economic conditions. Fair Trade increases the level of welfare and reduces economic and social inequalities (Becchetti L. Costantino M., 2006), (Becchetti L., Paganetto L., 2003), (Ronchi L., 2002), (Castro J.E., 2001). The negative impact for the less competitive countries (e.g. sub-saharian Africa) and producers (small producers in remote rural areas) due to the reduction in agricultural international trade barriers (Conforti P., Velazquez B.E., 2004), (Robbins P., 1999) can also be reduced. Fair trade contributes in fact to the products' differentiation, positively affecting their demand. Promoting a Fair Trade related international agricultural trade is also a way to increase the consumers awareness of their role in defining a more sustainable model of development under many aspects: social, environmental and economic.

2. Background

The consumption of Fair Trade products is quickly growing in the industrialised countries (Krier J-M., 2005 p. 7). The size of this market, and its impact on the rural communities in developing countries, is still quite small. The total Fair Trade sales in 2005, amounted to approximately US\$ 1.4 billion worldwide, a 37 % year-to-year increase over 2004 (FLO, 2006), but a mere 0.01% of the total world trade (US\$ 10,511 billions (WTO, 2006).

¹ The authors jointly prepared this paper; Lorenzo Paluan particularly contributed to paragraphs 2 and 6, Cesare Zanasi particularly contributed to paragraphs 1, 3, 4 and 5.

However, the interest in Fair Trade is growing in large national and trans-national food companies (supermarket chains, fast-food chains among others). It is not a case that the only countries where Fair Trade products (coffee and bananas), gain a significant market share are Switzerland and United Kingdom, where the supermarket chains play a key role in Fair Trade distribution (Krier J-M., 2005 pp. 30-31). As a consequence Fair Trade is facing a "growth crisis" which can be summarised by the debate between the "product certification" supported by FLO (Fairtrade Labelling Organizations International) and its FairTrade Mark, and "organisations certification" supported by IFAT, (International Fair Trade Organizations) and its Fair Trade Organisation Mark. IFAT is critical on the inclusion of supermarket chains and other non specifically Fair Trade oriented organisations in the distribution, unlike FLO which stresses the importance of a relevant quantitative growth of the Fair Trade market size. This debate is particularly strong among the Italian Alternative Trade Organisations (ATO's) (Liberomondo, 2004), (Commercio Alternativo, 2005). Fair Trade products are "credence goods" and also "merit goods" which heavily rely upon an effective communication, and certification, of the benefits that their consumption generates for the whole of the society. The demand for these products can consequently be affected if a conflict among Fair Trade organisations arises, reducing the consumer trust in the positive externalities for the society related to the Fair Trade. The interaction between market growth and ethics has therefore become a major concern for the Fair Trade movement. This problem is particularly felt in Italy where the size of the World Shops' distribution channel, strictly connected to IFAT, is still bigger than the Fair Trade distribution through the supermarket chains.

A study from Barbetta G.P. (Barbetta G.P., 2006 p.13÷19) provides an insight on the main problems the Italian World Shops and Fair Trade importers are facing:

- small economic size;
- relative scarcity of financial and human resources with respect to the range of professional skills required and variety of products sold;
- little transparency in the price formation mechanism and in the supply chain economic and technical relationship;
- need to increase external economies of scale and collaboration between Fair Trade companies, both vertically and horizontally.

The ATO's (and World Shops) business model deserves a closer examination in order to evaluate the consequences on their economic and ethical sustainability.

Different business solutions have been experimented or discussed in order to guarantee a growth respectful of the Fair Trade principles:

- differentiation in the products' distribution and marketing strategies between world Shops and supermarket chains. Supermarket chains will be mostly oriented on the quantitative growth, selling Fair Trade food and non food products on a large scale. World Shops should be more involved in the Fair Trade values communication and promotion.
- World Shop specialisation in a selection of few products (e.g. clothes, cosmetics and/or high quality artisan or food) following the traditional retailing specialising path of the last decades.

The respect of the principles of Fair Trade should in any case include, collaboration, transparency, and the promotion of the marginalised rural communities in the developing countries. A good starting point to encourage collaboration and transparency should be the reduction of barriers to the different agents communication. To this end logistics are of paramount importance thanks to their influence on the development of an efficient management of the physical goods and information flows along the supply chain (Pinna, R., 2005: 75). This will positively affect the competitiveness of the supply chain not only in cost reduction terms but also by increasing the product value for the consumer through, among others, an efficient communication of the values differentiating Fair Trade products. A more efficient information flow reduces information asymmetry and the risk of

opportunistic behaviour, supporting the reduction of inequalities in the income distribution along the supply chain, mainly for rural communities. In order to assess the influences of the growth strategies on the development of both the Fair Trade market size and the implementation of its ethical goals, the analysis should then involve an integration of a logistics and supply chain management approach with the transaction cost theory.

3. Objectives

The goal of this paper is to determine how the influence of the ATO's business models on the supply chain management performance (in particular logistics), influenced the growth strategies and potential support to agricultural Fair Trade flows.

4. Data and methodology

The most important Italian ATO's, almost exclusively operating in the Fair Trade market, are analysed. The variables have been collected through the ATO's websites², and by interviewing the ATO's management. The interviews were finalised to collect quantitative and qualitative information on the companies structure, performance, and to an in depth analysis of their strategies, organisation and management. The analysis was carried out in three different steps. In a first part the different degrees of vertical coordination needed by the ATO's, for an efficient supply chain management was assessed. The Hobbs e Young approach to the analysis of the relationship between transaction cost and vertical coordination was considered (Hobbs J. E., Young L.M., 2000).

²<http://www.altromercato.it/> ; <http://www.commercioalternativo.it/> ; <http://www.liberomondo.org/> ; <http://www.equomercato.it/> .

The authors consider that transaction costs are influenced by the level of uncertainty related to the relationship between the characteristics of the products traded and the type of transaction (see scheme 2).

Scheme 2) Relationship between product characteristics and type of transaction

	Transaction characteristics					
	Uncertainty for buyer: quality	Uncertainty for buyer: reliable supply timeliness and quantity	Uncertainty for buyer and seller: price	Uncertainty for seller: finding a buyer	Frequency of transaction	Relationship specific investment
Product Characteristics						
Perishability	V	V		V	V	
Product differentiation	V	V	V	V		V
Quality variable and visible		V	V	V		
Quality variable and invisible	V	V	V			
New characteristics of importance to consumers	V	sometimes	V	V		V
Regulatory drivers						
Liability	V			V		sometimes
Traceability				V		V
Technology drivers						
Company -specific technology						V
						sometimes

Source (Hobbs J. E., Young L.M., 2000)

Higher uncertainty leads to higher transaction costs and, consequently, to the need of a stronger vertical coordination within the supply chain. This approach can be summarised as follows:

Uncertainty associated to the type of transaction: it is linked to product quality and accessibility in terms of timing, quantity available and price level; level of specialisation of the investments needed to produce and distribute the product, (the higher the specialisation the higher the risk associated to the transaction) frequency of the transaction and its administrative and technical complexity

The uncertainty associated to the transaction is in turn influenced by the products characteristics: perishability, product differentiation, quality variability and visibility, need to trace the product, specific production technologies associated to the product.

Apart from ubiquitous Fair Trade products characteristics, affecting mostly the regulatory drivers, other ATO's structural variables were examined, in order to assess their different levels of vertical coordination need:

- the share of products sold by perishability: fresh food, other food, no-food;
- the turnover by type of distribution channel;
- the number of transactions.

In a second part the ATO's supply chain relationships were analysed in order to evaluate how they correspond to the supply chain coordination level required. The theoretical vertical coordination need was then compared to the actual level of coordination for each ATO. To attain this result the partnership relations along the supply chain were examined by interviewing the ATO's management and from the websites company's presentations.

The results of these first two steps were combined with the ATO's strategic goals analysis and supply chain performance indicators; this allowed appreciating how the ATO's managed to harmonize the consideration of the Fair Trade values with the necessity to compete, and grow, in a market economy. The logistics indicators reported by Vignati (Vignati G., 2002) were considered.

In particular the capacity of the ATO's to efficiently implement an adequate level of coordination was evaluated analysing their customer relationship:

- n. of clients, destinations and deliveries
- orders management in particular the communication technologies adopted for the orders transmission.
- logistics performance indicators; the performance indicators are considered relevant as efficient logistics reduces the risks and costs related to transactions; they increase a company (or supply chain) competitiveness by reducing the costs and increasing the market access. It also affects non monetary aspects like the communication of the company values (e.g. respect for the producers and consumer needs for safety, reliability, punctuality).

The logistics indicators reported in this paper are consequently mainly oriented towards the reliability, efficiency, timeliness and productivity of the internal and external logistics of the ATO's.

1) Delivery Reliability

- A1 stock breaking index: it indicates the frequency with which the demand cannot be satisfied from the stock.
- A2 % of orders fulfilled/ total orders
- A3 % of orders unfulfilled/total orders
- A4 % orders fulfilled with multiple deliveries
- A5: % of orders fulfilled within the customer's requested date (delivery performance to request date)

2) Inventory management performance

- E1 Inventory Turnover by product category : is the ratio of the cost of annual sales to the average inventory level. The higher the inventory turns, the better the firm uses its inventory assets. Measuring the index by products categories allows a better evaluation of the different products supply chain management performances (Cost of Sales / Average Inventory Level)
- E2 Days of supply by products category: n.of days the demand for the different products categories can be satisfied by the existing inventory (Average inventory / cost of a day's sales).
- E3 Use of available warehouses areas and volumes: (e.g. % pallet racks area/ total warehouse area). Indicates the warehouse operative efficiency. E.g. pallet racks can be used from 45-50% up to 90% of the warehouse area and volume. The higher the area covered the higher the space utilisation efficiency (Vignati G., 2002 pp. 232 -233).

3) Order fulfilment timeliness

- T1 Delivery Lead Time: The total time that elapses between an order's placement and the products delivery.
- T2 actual delivery date/ agreed delivery date ratio

4) Warehouse operational efficiency

- P1 Reception operational time (e.g.: handling units³ received/time)
- P2 Placement operational time (e.g.: handling unit placed/time)
- P3 Picking operational time (e.g. n° of daily deliveries; n° of pallets picked and delivered ;)
- P4 Wrapping and Packing operational time
- P5 Vehicle uploading operational time

The Business models structure (business model building blocks) as defined by Osterwalder (Osterwalder A., 2004 p.43) provided a useful tool for organically collect and describe the variables influencing the analysis.

5. Results

First of all the ATO's *value propositions* and *target consumers segments* were examined to provide information on their ethical principles and business strategies.

Value propositions

Fair Trade objectives defined by FINE⁴ are a common value proposition for the ATO's: "Fair Trade is a trading partnership based on dialogue, transparency and respect that seeks greater equity in international trade. It contributes to sustainable development by offering better trading conditions to, and securing the rights of, marginalized producers and workers - especially in the South. Fair Trade organizations (backed by consumers) are engaged actively in supporting producers, awareness raising and in campaigning for changes in the rules and practice of conventional international trade."

The objectives of Fair Trade imply, among others, a progressive reduction of the role of raw material agricultural export as an engine of growth, encouraging local communities' social, environmental and economic development. The products characteristics and services should therefore be designed to meet the expectations of an ethical consumer. Fair Trade "incorporates values in their products" (Becchetti L., 2006)

The ATO's examined include some level of differentiation regarding their approach towards the consumers, affecting the value of the product, in particular

- CTM Altromercato and Commercio Alternativo stress the importance of integrating the ethical principles of solidarity, social and economic justice with a sound management and organisational capacity making Fair Trade companies competitive (Commercio Alternativo, 2007). The growth in the market size, obtained through collaboration with non Fair Trade companies (e.g. supermarket chains) also represents an important strategic difference with the other ATO's.
- Liberomondo and Equomercato are more oriented towards the social and political consequences related to Fair Trade. Equomercato stresses the importance of building a political alternative to the market economy supporting cooperation as opposed to competition and promoting the Fair Trade values through the education of consumers and producers (Equomercato, 2007). Liberomondo, a social cooperative, is more oriented towards the social impact of Fair Trade as a tool to enter the labour market for socially marginalised people both in developing and developed countries and to create an integrated "ethical supply chain". (Liberomondo, 2007). It links the international circuits of Fair Trade to the Italian social economy.

Target customer segments

All sectors of society are represented: students (17%), office workers (16%), housewives (14%) and blue-collar workers (14%); the remaining are managers, professionals, farmers,

³ Handling units: pallet, cartons etc.

⁴ FINE is an informal network that involves the Fair Trade Labelling Organizations International (FLO), the International Federation for Alternative Trade (IFAT), the Network of European Shops (NEWS!) and the European Fair Trade Association (EFTA)

teachers and intellectuals (Musso D. 2004). The profile of the typical Fair Trade consumer is the “ethical” consumer, often engaged in volunteer associations and generally interested in alternative model of consumption; this attitude influences the level of awareness of the social contents of Fair Trade and significantly affects consumption (Becchetti, 2006).

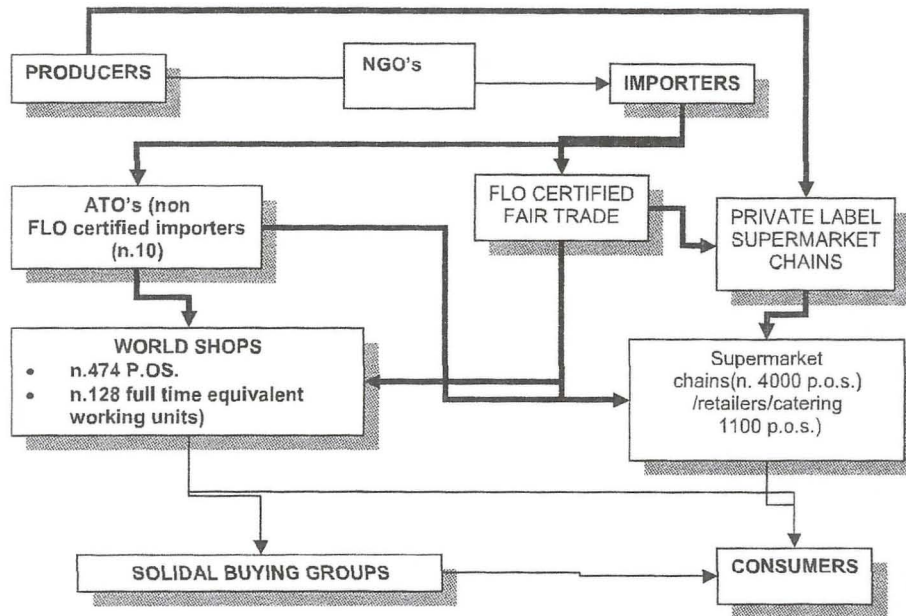
The analysis of the needs for and effectiveness of, vertical coordination along the ATO’s supply chain gave the following results.

Vertical coordination need

Distribution channels

The Italian Fair Trade distribution structure (Scheme 1) is basically defined by two main channels, partially overlapping, mirroring the two different strategic approaches to Fair Trade above examined. At the producers level these differences are not relevant: the producers start up phase is nearly always supported by NGO’s or other international cooperation organisations; their role is important as Fair Trade involves not only production and distribution, but also social and environmental projects for the local community development, funded by the premium granted by the Fair Trade labelling system managed by FLO. Once the producers become FLO registered they can directly sell to traders. The distribution involves a complex relationship between importers and retailers. A network of 474 World Shops operates in Italy, sometimes related with solidal buying groups; these shops are managed by 347 different organisations representing non profit-associations or social cooperatives; food represents 40-50% of their total turnover (Musso D., Perna T., 2005, p. 17).

Scheme 1) Structure of Fair trade distribution channels in Italy



Source: The Fair Trade Advocacy Office, our survey

Fair Trade products are also sold by the traditional retailing sector (shops and supermarkets); they buy their products either from FLO licensed importers and in few occasions from the ATO's, not necessarily FLO certified, or directly from the producers (acting as importers). The ATO's are mostly supplying the World Shops network. They buy raw material from FLO registered producers and sell their products sometimes as private labels for supermarket chains; part of the World Shops (about 50) sell also FairTraded Mark products following the FLO standards.

The large agro-food companies involvement in the Fair Trade market is growing while the most important Alternative Trade organisations (ATO's) and World Shops growth is slowing down (tab.1).

The data on the ATO's turnover from 2001/02 2005/06 showed that CTM Altromercato is by far the main player; in the year 2004/2005 CTM concentrated 76% of the total turnover of the companies considered; the remaining three ATO's have a much smaller economic size. The turnover growth was negative for CTM from 2002/03 to 2005/06 while the other small ATO's grew at a very quick pace (table 1). The importance of the still relative small size of Fair Trade should not be underestimated when studying the variables influencing its development. These trends were in fact strongly influenced by conjunctural aspects. The main cause of CTM negative performance was in fact due to a reduction in CTM's main client orders of bananas. The behaviour of one client (a supermarket chain) influenced the trend of the entire Italian Fair Trade market growth.

Tab 1) Main Italian Fair Trade Importers Turn over (€ current)

	2002/03	%	2003/04	%	2004/05	%	2005/06	Var. 2002/03- 2005/06 %
CTM Altromercato *	31.820.000	82	34.240.000	79	31.253.000	76	30.309.301	-4,7%
Commercio Alternativo **	4.275.488	11	4.962.215	11	5.221.088	13	5.200.000	21,6%
Liberomondo **	1.698.181	4	2.711.909	6	3.053.166	7	3.480.305	104,9%
Equomercato **	1.135.458	3	1.394.936	3	1.415.188	3	1.393.610	22,7%
TOTAL	38.929.127	100	43.309.060	100	40.942.442	100	40.383.216	3,7%

* For CTM ALTROMERCATO, Commercio Alternativo and Equomercato the fiscal year ends on June the 30th, for Liberomondo fiscal year and solar year coincides.

** Liberomondo balance sheet includes around 200.000 € due to the direct participation in the management of two World Shops.

Source: our survey

Moreover, Fair Trade is growing thanks mainly to volunteers operating in a relatively large numbers of small ATO's and World Shops which still represent the most important clients for the main ATO's, including those linked to the supermarket chains.

The ATO's turnover by distribution channels (see tab. 2) confirmed the role played by the World Shops as the most important retailing channel of Fair Trade products. Following the different values proposition CTM Altromercato and Commercio Alternativo showed a higher share of products sold to the supermarket chains (21% and 30% respectively). Commercio Alternativo is developing new distribution channels like coffee shops, small restaurants and Fair Trade dedicated supermarkets, while CTM is distributing its products through catering companies (5%).

Liberomondo and Equomercato sell their products nearly exclusively to the World Shops (90%) and other small retailers.

Tab.2) Turnover by distribution channels (%) year 2004/2005 (2005/2006)

	World Shops	Supermarket chains	Retailers	Catering	export	other
CTM Altromercato	56 (60)	21 (13)	7 (6)	5 (6)	(11)	(4)
Commercio Alternativo	70	30				
Liberomondo	90		10			
Equomercato	90		10			

Source: our survey

The products sold are mainly food; at Commercio Alternativo and Liberomondo 70% of the references are non perishable food and 30% fresh food. Similarly 59% of CTM' references are non perishable food, and 21% fresh (food is mainly sold to the supermarket chain) while 16% are non-food references. CTM entered the Fair Trade cosmetics market, as a strategy to find new markets for the developing countries non food agricultural products (agave oil, essential oils and herbal remedies)

Liberomondo represents the only exception: 90% of the references sold are in fact non-food (handicrafts) and 10% (non fresh) food.

Tab. 3: Turnover by products categories - % (n° references) year 2004/05

	Food	Fresh food	Non – food
CTM Altromercato	59 (230)	21	16
Commercio Alternativo	70 (300)	30	
Liberomondo	70	30	
Equomercato	10		90

Source: our survey.

Theoretical vs. actual supply chain vertical coordination

The business model analysis showed a general need for strong vertical coordination for the whole of the companies involved in Fair Trade; the factors affecting to the same extent the level of transaction costs are related to the Traceability and partially to the New characteristics of importance to consumers (see scheme 2). The influence of the New

characteristics of importance to consumer (that is the Fair Trade values) is related to the share of product traded under the Fair Trade Organisation Mark; this Mark involves all the supply chain agents, and no official external certification body, encouraging a stronger vertical coordination when compared to FLO certified products.

Other factors influencing at different levels the need for coordination among the ATO's examined are perishability, product differentiation, quality variable and visible, quality variable and invisible, associated mainly to fresh products (e.g. fruits) but also to preserved or processed food (e.g. tea, coffee) whose quality can be affected by the presence of microorganisms. Higher transaction costs seem to apply to CTM Altromercato and Commercio Alternativo.

According to the Hobbs approach these higher costs are related to these ATO's:

- larger share of fresh (perishable) products traded; this also positively affects the share of quality variability, both visible and invisible and the traceability costs associated to food trade.
- larger share of business to business relationships involving more demanding trading relationship (supermarket chains, coffee shops, restaurants etc...); the risks related to the right timing, quantity and quality in the orders management are consequently higher;

The same conditions partially apply to Liberomondo; this ATO is oriented towards fresh food trading and is related to a very high number of small clients (World Shops and small traditional retailers. The need for coordination is however less demanding in terms of management, including the monitoring, when compared to more "conventional" clients like supermarket chains or catering.

Equomercato has a relatively lower need for coordination, given the prevailing trade in non food products; these products are generally non perishable. Liberomondo and Equomercato trade involve only the IFAT Fair Trade organisation Mark; a strong vertical coordination, in terms of transparency and information sharing, is thus necessary to reduce the uncertainty related to the respect of the Fair Trade principles along the different supply chain stages. However this is less influent on the necessity to grant an efficient flow of physical goods through better logistics management.

The supply chain partnership analysis showed that all the ATO's manage cooperation development projects with local producers from developing countries, directly or through NGO's; the contractual relationship is therefore a long term one; they provide technical, managerial and financial support. The creation of cooperatives among local producers is encouraged not only to increase the economic efficiency but also to promote social welfare and ethic values (workers rights, justice, and equality). Equomercato is strictly related to working children organisations around the world; it supports their activity by importing their products, realized under working conditions respectful of their dignity and educational needs, and information campaigns on the children organisation activity. Very often processing companies are related to the ATO's through strategic alliances and the ATO's are directly involved with the management and/or property of the retailers (World Shops). CTM Altromercato is a consortium of 130 associations and social cooperatives; they manage more than 350 World Shops.

Commercio Alternativo is a cooperative among 50 different organisations including World Shops (which in turn directly import and distribute Fair Trade products, like Equoland and Ravinala) and NGO's involved in cooperation projects in developing countries.

A certain amount of networking among ATO's procurement also exists; in case they cannot meet the demand with their stock they buy product from other ATO's.

A high level of coordination between the ATO's and the other supply chain agents resulted. The ATO's seem to play a central role in the supply chain management.

Efficient management of the supply chain relations

The business model analysis showed a correspondence between the coordination needs and the client/supplier relationship structure, along the different ATO's supply chains, and

between ATO's. Some specific features in the supply chain relationship (Customer and suppliers relationship) were examined to assess how effectively the coordination is managed.

Customer and suppliers relationship

The complexity of the ATO's customer trading relationships is confirmed by the analysis of the number of their clients, destinations and deliveries in the year 2004/2005 (tab.4). The data relate to Commercio Alternativo and Equomercato. The ATO's managers interviewed confirmed they are representative of the entire ATO's performances. The fragmentation is very high, Commercio Alternativo shows an average 10 shipments/year/client; the average shipment value is 673€. The number of shipment for each destination is 5. The yearly Commercio Alternativo turnover/n.of clients is 6600€; even lower the Equomercato figure: 2500€.

Tab.4) Clients, destinations, shipments

	Clients (n.)	Destinations (n.)	Shipments (n.)	Turnover/Clients (€)	Turnover/Shipments (€)	Shipments/ Destinations (n.)	Shipments/Clients (n.)
CTM Altromercato							
Commercio Alternativo*	786	1580	7760	6643	673	5	10
Liberomondo*							
Equomercato	571			2478			

Source: our survey

It was not possible to calculate the distribution of the clients/destination/shipments by size. According to Christopher (Christopher M. 1998) it is reasonable to assume that the Pareto distribution apply to these cases (80% of the sales comes from 20% of clients/destinations/shipments and vice versa). Therefore many of the shipments involve very small volumes and/or values.

Another relevant indicator of the customer relationship management efficiency is the orders transmission/management mode (tab.5). The on-line mode is largely adopted by the ATO's; only Liberomondo relies (at least up to the year 2004/2005) upon e-mail and other off-line modes.

Tab.5) Order preparation/transmission mode (%) year 2004/2005

	On line	e-mail	other
CTM Altromercato	99		1
Commercio Alternativo	35	45	20
Liberomondo		50	50
Equomercato	50		50

Source: our survey

CTM Altromercato uses CRM software and practically the entire Customer relationship management is on-line. The on-line order transmission mode regards 50% and 35% of the orders of Equomercato of Commercio Alternativo respectively. The amount of Commercio Alternativo orders on line has lately improved thanks to the introduction of new CRM software. The use of CRM software encourages a better and more transparent logistic management both internal and external (outbound in this case). The off-line orders reaching Equomercato (50% of total orders) are generally fulfilled by an on-site (warehouse) order transmission and/or consignment.

The analysis showed an extensive use of ICT's (Information and Communication technologies); this reduces the technological constraints to an efficient supply chain management, influencing the efficiency of the client customer interface.

On the negative side the large share of food traded, the high number of references, clients, deliveries, orders and shipments involved, and the differentiation in their activity, increase the complexity and costs related to the logistics and administration. On the supply side the product flows from farmers in developing countries and the international carriers' availability were taken as exogenous variables.

An efficient logistics management could reduce not only the costs but also improve the access to a growing market by reducing the constraints to the products flow along the supply chains. To this end an analysis of the ATO's logistics has been carried out.

Tab. 6a) Warehouse management, indicators adopted

	A1	A2	A3	A4	A5	E1	E2	E3	T1	T2
CTM Altromercato	X				X	X		X	X	X
Commercio Alternativo	X							X	X	X
Liberomondo								X	X	X
Equomercato								X	X	X

Sources: our survey

The data refer only to the usage of reliability, timeliness, flexibility and productivity indicators (see tabb. 6a e 6b). The actual values were not available. The amount and type of indicators adopted by the different ATO's can be considered as a proxy of their logistic management efficiency. This information was integrated by interviewing the ATO's managers who provided insights on the reasons leading to their choice of monitoring level and on the logistics performance.

The number of indicators adopted seems positively related to the ATO economic size and transaction costs level. In particular CTM shows a much higher number of logistics indicators adopted, when compared to the other ATO's.

Focusing our attention on each indicator the following results emerged:

indicator A1 (the stock breaking index) and A2-A3 (orders fulfilled and unfulfilled/total orders) are adopted by CTM Altromercato and Commercio Alternativo. They are very useful in order to measure the ATO's efficiency with respect to the adjustment of the inventory level to the demand flow and the order fulfillment reliability.

In particular CTM has a special contractual agreement with its customer concerning the food trade. A constant stock availability for the 50 more demanded references is granted; this should prevent these products from stock breaking. The risk of supply shortage is in fact generally high when dealing with developing countries, particularly with those countries facing instability due to human or natural causes.

The need to grant a reduction in the stock breaking led Commercio Alternativo to build a new warehouse specifically dedicated to the most important references. At the moment the increase in warehouses spaces specifically dedicated to increase the food stock, represents the most important investment in order to grant a better logistic service to their clients. Index A4 (orders fulfilled with multiple deliveries) is not measured by any of the ATO's examined.

CTM Altromercato is the only ATO measuring the % of orders fulfilled within the customer's requested date (indicator A5).

To better appreciate the influence of the monitoring of these indicators on the ATO's performances it must be remembered that CTM and Equomercato clients directly manage the orders on line, on the base of the stock availability; the orders from the clients are directly printed for the picking, the order form information are automatically sent to the invoice and accompanying documents. The chance of stock breaking or of problems related to the order fulfilment is consequently close to zero. Commercio Alternativo and

Liberomondo, do not measure the amount of orders partially fulfilled, in any case they do not fulfil orders with multiple deliveries.

The inventory management performance indicator E1 (inventory turnover by product category) is only measured by CTM Altromercato.

No ATO's measure indicator E2 (days of supply by products category); CTM used to measure it but is now considered not relevant. So far Commercio Alternativo did not calculate inventory management performance indexes. As a consequence of the recent investments in a new warehouse and implementation of a customer relationship management and logistics software, these indicators will be adopted.

Index E3 (% of available warehouse areas and volumes used) is measured by all the ATO's examined.

The order fulfilment timeliness T1 and T2 (delivery lead time and actual delivery date/agreed delivery date) is taken into consideration by the ATO's, but not on a regular basis.

tab. 6b) Warehouse productivity, indicators adopted

	P1	P2	P3	P4	P5
CTM Altromercato	X	X	X	X	X
Commercio Alternativo					
Liberomondo					
Equomercato					

Source: our survey

The warehouse productivity (Tab.6b) was only measured by CTM Altromercato in the year 2002/2003, to verify the opportunity to externalise the picking. The result was that the internal management of picking was considered more efficient. Other ATO's considered that the measurement of the warehouse productivity as an excess of control over the workers.

6. Final remarks

The ATO's business model analysis provided information on the different companies' strategies and capacity of managing a sustainable ethical and economic growth. The relationship between their strategic goals, supply chain organisation and management, in particular the logistics performance indicators, were useful to this end.

The ATO's examined showed a level of vertical coordination compatible with their coordination needs, values assumptions and economic size.

When considering the strategies of growth the analysis showed two different types of ATO's. One is more oriented towards increasing the volume of goods traded not only by promoting the consumers awareness towards the ethical content of Fair Trade products, but also competing on the more traditional ground of quality and managerial efficiency. This implies the adoption of more sophisticated supply chain and logistics management tools

and procedures, a closer relationship with more traditional distribution channels also emerged. These type of ATO's partially match the definition of "imprese sociali del Cees" (Fair Trade social enterprises), as proposed by Barbetta when analysing different types of World Shop (Barbetta G.P., 2006 p. 38). These ATO's are oriented to increase their investments in logistics.

On the other hand the smaller ATO's maintain a business model based on a small size, little interest in competing within the traditional market as a strategy to increase their turnover. The focus of their strategy is in fact the definition of an alternative way of dealing with economic activity by promoting the ethical awareness of the consumers and the social development of the whole of the agents in the Fair Trade supply chain.

This led to an exclusive relationship with the World Shop circuit, whose structural characteristics are less efficient in granting access to a large number of consumers, when compared to conventional trading and retailing channels; it also implied a marketing policy "producer oriented"; the support to the marginal farmers in the developing world is in fact considered a priority with respect to the consumers need for reliability, timeliness and affordable prices. This influenced the logistic integration that does not seem to be encouraged to the same extent in the smaller ATO's.

The risk associated to this strategy, whose goals are projected in a relatively distant future, is that more traditional trading and retailing big companies meanwhile can greatly increase their market dominance, also taking advantage of the Fair Trade values promotion coming from the ATO's and World Shops.

The ATO's growth strategies seem more influenced by their value propositions than the lack of managerial skill or unfavourable market conditions, at least in the smaller ATO's.

The analysis confirmed that the supply chain organisation is not "neutral" but is influenced by the company values and in turn influences the company economic as well as "ethic" sustainability.

The conflict between an organisation necessity of growth (or survival) to grant its economic sustainability in the long run, and the respect of its ethical code is far from being solved.

A contribution to overcome this apparent contradiction could be related, in our opinion, to the consideration of the entire range of theoretical and operational tools available to business management, without prejudices. An efficient flow of goods and information along the Fair Trade supply chain is in fact necessary both to the more ethical and "market oriented" ATO; in this sense the Fair Trade values, oriented towards transparency and collaboration, represent a potential competitive advantage with respect to conventional supply chains. The importance of opportunistic behaviour, as an obstacle to the flows of information and to a collaborative management, should be in fact smaller.

Future research developments should therefore investigate the monetary and non-monetary variables affecting the efficiency and sustainability of Fair Trade inter firms' relationships (clusters, networks, supply chains etc...).

A more specific field of investigation should be oriented towards the analysis of the Fair Trade flows from developing countries both in terms of goods and information. A fair income distribution and in general economic and social justice need transparency and therefore a full, fast and clearly organised access to relevant information and knowledge.

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Physiological responses of grapevines to biodynamic management

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Abstract

A 3-year (2011–2013) field trial was carried out in a mature vineyard (*Vitis vinifera* L., cv. Sangiovese), planted in 2003, to assess physiological responses of grapevines to biodynamic management. Starting in 2007, the vineyard was managed with organic production protocols in accordance with EC Regulations (834/2007). In 2008, the vineyard (2 ha) was divided in two large plots, with each plot having similar soil physico-chemical properties. One of the plots was managed with organic protocols per EC Regulations and the other with biodynamic practices, consisting of spray application of preparations 500, 500 K, fladen and 501. During the 2011–2013 season, the biodynamic preparations were used at least twice per year, with the exception of 501 that was applied only once in 2013. Concentration of hormones and mineral elements in biodynamic preparations were determined. Biodynamically managed vines showed lower stomatal conductance in all years and lower leaf water potential in 2012. Leaf photosynthetic activity was not influenced by cultivation method. Biodynamic management led to an increase in leaf enzymatic activities of endochitinase (EC 3.2.1.14), exochitinase (β -N-acetylhexosaminidase, EC 3.2.1.52 and chitin 1,4- β -chitobiosidase) and β -1,3-glucanase (EC 3.2.1.39), which are typically correlated with plant biotic and abiotic stresses and associated with induced plant resistance. Year effects were observed with 1,3- β -glucanase, whose activity in 2012 was 4.1-fold higher than in 2013. Disease incidence and grape yields were not different between organic and biodynamic treatments. This study provided a strong indication of a stimulation of natural defense compounds in grapes grown under biodynamic cultivation, but subsequent effects on plant protection and productivity require further evaluation.

Key words: *Vitis vinifera*, organic and biodynamic viticulture, stomatal conductance, biodynamic preparations, induced resistance

Introduction

Increased consumer awareness of environmental pollution in agriculture and the importance of food quality in relation to human health have encouraged the practice of alternative agronomic strategies, such as organic and biodynamic farming (Ponzio et al., 2013). The countries with the largest organic food markets are the USA, followed by Germany and France (Willer and Lernoud, 2014). Italy ranks sixth in global organic food markets

at \$1.95 billion compared with \$23 billion in the USA (Willer and Lernoud, 2014). In the viticultural sector, the organic trend is particularly pronounced, due to the cultural and social role played by wine-making and the attention paid to the whole production and bottling cycle.

According to FIBL and IFOAM surveys (Willer and Lernoud, 2014), over 280,000 ha of organic grapes were grown in 2014, which constituted 4% of the world's grape growing area (7 million ha in 2011 (Food and Agriculture Organization of the United Nations)). In Europe, 240,000 ha, representing 6% of the harvested grape area, is under organic management. Spain, France and Italy represent the countries with the largest organic grape area, which includes more than 55,000 ha of

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organic grapes (Willer and Lernoud, 2014). A considerable increase in the supply of organic grapes is expected from these countries (Willer and Lernoud, 2014).

Approximately 147,000 ha are managed worldwide according to Demeter biodynamic standards. There are 520 Demeter wineries in the world, with a total of 8000 ha of vineyards (Demeter International, 2012). Biodynamic viticulture is spreading the fastest in Argentina, Chile and France. Biodynamic viticulture techniques can vary, depending on the grower's beliefs and rates of adoption. However, biodynamic growers face similar restrictions as organic producers regarding the disallowance of synthetic pesticides and fertilizers. Overall, biodynamic farming constitutes a holistic approach relying mostly on natural resources (Lotter, 2003). This perspective is achieved through the compulsory use of a set of specific fermented preparations applied on crops or soil in very small amounts. These preparations, most of them proposed by Rudolf Steiner (Steiner, 1924), are claimed to stimulate the soil nutrient cycle, enhance photosynthesis, and assist in optimal evolution of compost, increasing both soil and crop quality (Koepf et al., 2001). Biodynamic management is considered to induce beneficial environmental effects on the energetic efficiency of sustainable agro-ecosystems (Turinek et al., 2009) by intercepting, storing and multiplying cosmic forces to confer vitality to soil and plants (Steiner, 1924).

Biodynamic preparations applied to soil, compost and crops have been reported to promote efficient cycling of nutrients, stimulate soil and plant vitality, and improve animal health and crop quality (Pfeiffer, 1983; Turinek et al., 2009). These substances are not expected to act as fertilizers, but rather to 'harmonize environmental processes that naturally occur', enabling the plant to grow in a balanced way (Koepf, 1989).

The biodynamic farm proposes to be a self-sufficient system with all fertilizers and animal feed produced on the farm. Growers following the Demeter Protocol adopt specific management strategies in the vineyards for soil (e.g., tillage without turning over soil) and canopy (no shoot trimming). In the winery, spontaneous fermentation is practiced instead of fermentation by the use of commercial yeasts. However, several growers adopt biodynamic practices without following any specific private certification protocols. Although biodynamic currently represents an alternative agricultural cultivation method, some factors (e.g., agronomic, economical, institutional, commercial and social) may discourage its implementation in vineyards. Currently, there is little evidence regarding the agronomic effects of biodynamic practices, necessitating scientific investigations that will play a crucial role in providing objective information on the agronomical and physiological behavior of crops, such as grapes.

Several investigations have highlighted the phytoiatric effects (e.g., plant resistance-inducers) of microbial products of potential use in organic farming (Schmitt et al., 2004; Tamm et al., 2011). However, control of the main

grape pathogens, *Plasmopara viticola*, *Uncinula necator* and *Botrytis cinerea*, is troublesome due to few protective treatments and because of the restriction on the amount of copper—limited to a maximum of 6 kg ha⁻¹ yr⁻¹, regardless of cultivation method (EC Regulation 473/2002) (EC, 2002). In addition, the use of sulfur-containing compounds (Rauhut, 2009) may cause adverse effects on the sensorial properties of the wine (e.g., off-flavor). Finally, there are limitations on the amount of sulfites that can be added to the must during wine-making (EC, 2012) (e.g., 100 mg L⁻¹ for organic red wine). Consequently, in organic and biodynamic vineyards, all field strategies, including canopy and soil management, strive to preserve and enhance plant health and resilience under biotic and abiotic stresses.

Research on the effect of biodynamic cultivation on grape physiology and productivity has been limited to one study of Reeve et al. (2005). On the other hand, the influence of biodynamic preparations on berry and wine composition and quality has been relatively extensively investigated (Reeve et al., 2005; Parpinello et al., 2015). Parpinello et al. (2015) demonstrated that the quality of 'Sangiovese' red wine was affected, to a great extent, by the application of biodynamic preparations. Moreover, by using 1H-NMR (Laghi et al., 2014), it was possible to discriminate between red wines from organic and biodynamic grapes. Such discrimination was also achieved by the droplet evaporation method (DEM) (Kokornaczyk et al., 2014).

The scientific literature on biodynamic grape cultivation almost exclusively focuses on berry and wine quality, without considering the important role played by leaves in plant physiology and health. Various explanations regarding the mode of action of biodynamic preparations on plants exist, including hormonal stimulation, and enhancement of plant growth, particularly at the root level (Stearn, 1976; Fritz and Köpke, 2005).

Plant hormones are organic molecules with the ability to regulate physiological, biochemical and metabolic processes in roots and shoots through the interaction with specific membrane receptors involving long-distance-signaling pathways, which in turn include specific secondary messengers of an organic or inorganic nature (Santner and Estelle, 2009). Major plant hormones are auxins (indole-3-acetic acid, IAA), abscisic acid (ABA) and cytokinins (CKs), although other classes of molecules are emerging as new plant hormones, such as salicylic acid and jasmonic acid (Shan et al., 2012). Auxins are involved in the regulation of plant developmental phases, such as phototropism, geotropism and hydrotropism. They also play a relevant role in the regulation of cell elongation and the development of lateral roots and absorbent hairs. The CKs are involved in the regulation of cell division and tissue differentiation, but also play a relevant role in the control of shoot:root balance, nutrient transport and root-to-shoot translocation as well as delaying leaf senescence. Main CKs derived from adenine and are

classified as aromatic CKs (topolin-types, benzyladenine) and isoprenoids (zeatin-types, isopentenyl-adenine-types) (Santner and Estelle, 2009; Shan et al., 2012). Abscissic acid is involved in the regulation of plant water homeostasis (leaf transpiration, stomatal closure) under osmotic stresses (Santner and Estelle, 2009; Shan et al., 2012).

Regulation of bacterial activity from biodynamic cultivation has also been reported; for example, lower values of the metabolic quotient for CO₂ were noted, suggesting higher complexity and diversity of soil microbial communities receiving long-term treatment of biodynamic preparation (Miller and Bassler, 2001). Chemical and molecular analysis conducted by Spaccini et al. (2012) on Horn Manure 500 preparation showed a complex composition of substances, including derivatives of lignin, and cyclic or linear lipids of plant and microbial origin. According to the authors, this particular molecular composition would make the 500 preparation more degradable than common compost, due to the high content of aromatic derivatives of lignin that are potentially more biologically active, promoting plant growth (Spaccini et al., 2012).

The hypothesis concerning the hormonal mode of action of biodynamic preparations proposed by Stearn (1976) was not supported by experiments and therefore remains questionable. It is well known, however, that plants exposed to a variety of biotic and abiotic stresses respond by inducing defense mechanisms (Kuc, 2001; Van Loon et al., 2006). Plants have the ability to acquire an enhanced level of resistance to pathogen attack or to different environmental changes after being exposed to several biotic or abiotic stimuli (Van Loon et al., 2006). Natural defense mechanisms of plants provide an alternative, non-conventional approach for plant protection through the use of new natural chemicals or bioagents (Dixon, 2001; Alabouvette et al., 2006). In grapes, stimulation of defense mechanisms was evidenced under various types of abiotic stresses or elicitor treatment in leaves, berries and inflorescences, as revealed by the increasing expression of genes encoding pathogenesis-related (PR) proteins or the stimulation of their corresponding activities (Trotel-Aziz et al., 2006; Petit et al., 2009). Both chitinase and glucanase activities have been detected in grapevine leaves following different stimulation (Derckel et al., 1996; Busam et al., 1997; Giannakis et al., 1998; Kikkert et al., 2000; Reuveni et al., 2001; Magnin-Robert et al., 2007). Several PR proteins have been characterized at the molecular level and have shown antifungal activity *in vitro* (Datta and Muthukrishnan, 1999). Some of them also have shown enzymatic activities, such as β -1,3-glucanase and chitinase, which are involved in the degradation of microbial cell wall structural polysaccharides (Kauffmann et al., 1987; Legrand et al., 1987). Salicylic acid, a well-known resistant inducer, was able to increase the basal leaf activity of chitinase by factor of 5.5 (Derckel et al., 1996). Bacteria applied by drenching cv. Chardonnay (*Vitis vinifera*) roots were also able to increase chitinase and β -1,3-glucanase foliar activities from two- to fourfold (Magnin-Robert et al., 2007, 2013).

To our knowledge, there are no studies on the presence of hormones and potential resistance-inducing compounds in biodynamic preparations and their effects on biochemical defense mechanisms in grapes. In view of the above-mentioned considerations, this research aimed to characterize the composition of biodynamic preparations and evaluate their effects on leaf gas exchange, potential induced resistance and subsequent yields in 'Sangiovese' grapes in a Mediterranean climate.

Materials and Methods

Site description, experimental design and vineyard management

The long-term experiment was performed from 2008 to 2013 in a mature vineyard planted in 2003 with cv. Sangiovese grapes (clone FEDIT 30 ESAVE), *V. vinifera* L., grafted onto Kober 5BB, trained to spur pruned cordon (VSP). The vineyard was located in Tebano (Faenza, Emilia Romagna, Italy (44°17'7"N, 11°52'59" E, 117 m a.s.l.), on a medium slope, with southeast/northwest and downhill-oriented rows. Vines were spaced at 2.8 m × 1.0 m (3571 plants ha⁻¹). Starting in 2007, this commercial vineyard was managed and certified as organic in accordance with EC Regulation 834, 2007 (EC, 2007). In 2008, the total surface (2 ha) was divided in two large uniform areas with similar soil chemical characteristics (Table 1). Each area was subjected to a specific cultivation method: (1) organic farming, managed according to the EC Regulation (EC, 2007) and (2) biodynamic farming, based on organic management, with the applications of biodynamic preparations according to Demeter standards. Each treatment covered seven plots, each with 12 monitored vines, for a total of 168 vines in the experiment. Randomization could have potentially caused problems in the management of this long-term experiment, due to possible effects of biodynamic preparations beyond the treatment area, including effects on soil microorganisms, mycorrhizal fungi-mediated nutrient accumulation (Cheng and Baumgartner, 2004) and metabolite exchanges.

In 2011–2013, the number of buds (12–14) and bunches (11–15) was adjusted by winter pruning and cluster thinning, respectively. At the end of each vegetative season, herbaceous species were sown in alternate planting rows, such as fava bean (*Vicia faba*), barley (*Hordeum vulgare*), subterranean clover (*Trifolium subterraneum*) and mustard green (*Brassica juncea*) in both organic and biodynamic plots. Soil was managed by mowing the vegetation during late spring, which maintained biomass on the soil surface. Beginning in 2007, no irrigation water was applied, and the vineyard was not fertilized. A total of 14 soil samples (one sample from each experimental unit) were taken at 0–40 cm deep during the first year of the experiment (2008). The analysis showed no significant differences in the observed parameters (Table 1):

Table 1. Soil chemical properties of organic and biodynamic experimental plots in 2008 at the beginning of the experiment.

Test type	Organic	Biodynamic	Significance
pH in H ₂ O	8.14	8.05	n.s.
Organic matter (OM)	1.9%	1.7%	n.s.
Total carbonates (CaCO ₃)	16.6%	18.7%	n.s.
Active lime (CaCO ₃)	8.11%	9.07%	n.s.
Total nitrogen (N)	1.42‰	1.31‰	n.s.
Assimilable phosphorus (P ₂ O ₅)	33.43 µg g ⁻¹	27.14 µg g ⁻¹	n.s.
Exchangeable potassium (K ₂ O)	248 µg g ⁻¹	289 µg g ⁻¹	n.s.
Exchangeable sodium (Na)	46.57 µg g ⁻¹	44.43 µg g ⁻¹	n.s.
Exchangeable calcium (Ca)	3763 µg g ⁻¹	3634 µg g ⁻¹	n.s.
Exchangeable magnesium (Mg)	311 µg g ⁻¹	277 µg g ⁻¹	n.s.
Assimilable iron (Fe)	19.49 µg g ⁻¹	18.35 µg g ⁻¹	n.s.
Assimilable manganese (Mn)	7.55 µg g ⁻¹	7.01 µg g ⁻¹	n.s.
Assimilable zinc (Zn)	1.92 µg g ⁻¹	2.08 µg g ⁻¹	n.s.
Assimilable copper (Cu)	12.97 µg g ⁻¹	16.27 µg g ⁻¹	n.s.
Assimilable boron (B)	0.48 µg g ⁻¹	0.45 µg g ⁻¹	n.s.
Cation exchange capacity (CEC)	22.1 meq/100 g	21.2 meq/100 g	n.s.

n.s., no significance ($P \leq 0.05$).

these loamy clay alkaline soils contained medium–low organic matter (1.8%) and nitrogen (1.4‰) concentrations, high levels of carbonates (total carbonates 17.6%; active lime: 8.6%), medium–high content of assimilable phosphorus (P₂O₅: 30 µg g⁻¹) and potassium ions (K₂O: 268 µg g⁻¹), as well as assimilable iron (19 µg g⁻¹) and manganese (7 µg g⁻¹). Available copper in the soil was around 15 µg g⁻¹.

Climatic conditions

Overall, the 2011 vegetative season was marked by average temperatures well above the seasonal normal, with temperature peaks of 30°C in August. From bud burst to harvest, the average relative humidity (RH) varied from 40 to 70%; highest values were observed during spring (92%) and the lowest (38%) during the latter part of August. The total rainfall (204 mm) from bud burst to harvest was sporadic during spring and almost absent during ripening. In 2012, the average temperature showed an increasing trend beginning in March (10°C) until August, and then stabilized around 30°C, at the end of the month. The average RH from bud burst to harvest varied from 35 to 70% showing the lowest value (37%) at the end of July, while higher peaks occurred during May (88%) and at the beginning of September (89%). The total rainfall (342 mm), registered from bud burst to harvest, mainly occurred in spring. In the 2013 vegetative season, the average temperature increased from March (10°C) until the beginning of August (32°C) when the maximum temperature was around 40°C. From bud burst to harvest, the average RH was in the range of 40–90%, with the lowest peak (41%) occurring at the beginning of July and the higher at the beginning of May (89%) and the end of

September (92%). The total rainfall recorded from bud burst to harvest was 433 mm and mainly occurred in spring, at the end of August (55 mm) and during the second half of September (52 mm).

Pest management and harvest sampling

Both organic and biodynamic experimental plots were treated to control diseases and pests in the same manner, using organic products allowed by the EC Regulation (EC, 2002). Treatments consisted mainly of copper (an average of 6 kg ha⁻¹ yr⁻¹) and sulfur (an average of 70 kg ha⁻¹ yr⁻¹), enabling control of fungal pathogens (*P. viticola*, *U. necator* and *B. cinerea*). At harvest, the incidence (number of affected clusters per vine) and severity (number of affected berries per cluster) of bunch rot were recorded for each cluster of 12 vines per experimental plot (84 per treatment).

Also at harvest, the number of clusters per plant, productivity per vine (kg) and bunch weight (g) (Wunder Digital Dynamometer, Wunder SA-Bi S.r.l, Milan, Italy) were determined on 12 vines per plot. After leaf abscission, pruning wood weight (kg) was recorded and the Ravaz Index (Ravaz, 1903) (yield/pruning wood ratio) was calculated on the same plants.

Biodynamic preparation characterization and application

The biodynamic preparations consisting of cattle manure-horn (500), 500 K, 501 (silica powder) and fladen were purchased from a regional producer (Fondazione le Madri, Rolo, Italy) and characterized in 2012, in our laboratory, using chemical analyses (see methods below).

The 500 preparation was manure from a healthy bovine placed in a bovine's horn, buried in the earth over winter for 6 months and unearthed in spring. To make fladen, a hole was dug, covered with sticks of birch and then filled with fresh and compact cow manure, without straw and inoculated with compost preparations. Eggshells and basalt were mixed together for 1 h with a spade, then placed in the ground, inside a box with its base open to the soil, for 8 weeks. The fladen preparation was used when dark brown, crumbly and free of manure smell. Prepared Horn Manure (500P or 500 K) was developed by Alex Podolinsky in Australia (Podolinsky, 1989). It is made from Horn Manure (500) into which the six compost preparations, normally used for making the compost pile, were added. Preparations were stored in glass jars with slightly loose lids and stored under cool conditions, in an untreated wooden box surrounded by peat. The box was placed in a location free of power lines. The peat was kept moist and the condition of the stored preparations was checked periodically. The horn cattle manure preparations were kept moist all the time. The Horn Silica (501) was composed of fine crushed quartz powder. The preparation was mixed with rainwater and transferred to cow horns and buried in the soil until late September or early October, when the horns were unearthed, contents were extracted and stored in a glass jar until the time of application.

The following preparations were used in the vineyard experiment from 2008 until 2013: 500, fladen 500 K 501. In 2010, trunk paste (130 kg ha⁻¹), a mixture of fresh cow manure, horsetail and stinging nettle infusion, sand, bentonite and water, was applied to the trunks to protect vines from biotic and abiotic stresses. In each application of cattle manure-horn (500; 100 g ha⁻¹), fladen (100 g ha⁻¹), 500 K (100 g ha⁻¹) were dissolved in 30 liters of warm water (32°C). Tap water was stored for a few days in a wooden barrel before the contents were dissolved. Through the process of 'dynamization' the water was energetically stirred until a deep crater was formed in the rotating liquid; then the direction of stirring was reversed in order to produce a 'chaotic turbulence,' before gradually creating a new crater in the other direction. After 1 h the liquid was allowed to settle and poured through a sieve into a copper backpack sprayer and the product was immediately sprayed as droplets onto the soil. The application was performed in the afternoon.

Horn Silica (501) was used in very small quantities (5 g ha⁻¹). This preparation was dissolved in warm water (32°C) and the stirring procedure was similar to the one described for 20 min. Horn silica was sprayed with a copper backpack sprayer as a fine mist over the plants during early morning close to sunrise. In 2011, 2012 and 2013, the biodynamic preparations were used as follows: two applications of cattle-manure horn were applied in the spring period; one application of 500 K after harvest in autumn; silica powder was sprayed in summer three times in 2011, twice in 2012 and once in 2013; fladen was applied twice in

2011 and 2012 and three times in 2013, according to the Maria Thun calendar, when possible. The application times were modulated according to environmental conditions and observations on plants.

Plant hormone analysis

The following plant hormones were studied in this experiment: zeatin (Z), dihydrozeatin (DHZ), trans- and cis-zeatin riboside (t-ZR and c-ZR), dihydrozeatin riboside, isopentenyladenine, isopentenyladenosine, IAA and ABA. The extraction and purification of plant regulators were carried out using the method described by Dobrev and Kaminek (2002) and Aguirre et al. (2009). Liquid Chromatography–Mass Spectrometry quantification of cytokines (CKs): the CKs were quantified by HPLC linked to a 3200 Q TRAP LC/MS/MS system (Applied Biosystems/MDS Sciex, Ontario, Canada), equipped with an electrospray interface, using a reverse-phase column (Tracer Excel 120 ODSA 3 mm, 100 × 4.6 mm², Teknokroma, Barcelona, Spain). A linear gradient of methanol (A) and 0.05% formic acid in water (B) was used: 35–95% A in 11 min, 95% A for 3 min and 95–35% A in 1 min, followed by a stabilization time of 5 min. The flow rate was 0.25 ml min⁻¹, the injection volume was 50 µl, and the column and sample temperatures were 30 and 20°C, respectively.

Liquid Chromatography–Mass Spectrometry quantification of IAA and ABA: these hormones were quantified by HPLC linked to a 3200 Q TRAP LC/MS/MS system (Applied Biosystems/MDS Sciex, Ontario, Canada), equipped with an electrospray interface, using a reverse-phase column (Synergi 4 m Hydro-RP 80 A, 150 × 2 mm², Phenomenex, Torrance, CA). A linear gradient of methanol (A) and 0.5% acetic acid in water (B) was used: 35% A for 1 min, 35–95% A in 9 min, 95% A for 4 min and 95–35% A in 1 min, followed by a stabilization time of 5 min. The flow rate was 0.20 ml min⁻¹, the injection volume was 50 µl, and the column and sample temperatures were 30 and 20 °C, respectively. Detection and quantification were performed by multiple reaction monitoring in the positive-ion mode, employing a multilevel calibration graph with deuterated CKs, IAA and ABA as internal standards. Compound-dependent parameters are described in Aguirre et al. (2009). The source parameters included the following: curtain gas: 25.0 psi; GS1: 50.0 psi; GS2: 60.0 psi; ion spray voltage: 5000 V for CKs and 4000 V for ABA, IAA; CAD gas: medium and temperature: 600°C. The source parameters included the following: curtain gas: 25.0 psi; GS1: 50.0 psi; GS2: 60.0 psi; ion spray voltage: 4000 V; CAD gas: medium and temperature: 600°C.

Elemental analysis

Concentrations of C (total and humic acid-C) and N in dried samples of biodynamic preparations were

determined by elemental analysis using a LECO CHN 900 analyzer (LECO Corporation, St Joseph, MI, USA).

In order to determine mineral nutrients (K, P, meso- and micro-nutrients) in biodynamic preparations, biodynamic preparation samples were dried at 100°C for 24–48 h in an air-oven, and sample digestions (250 mg of sample) were carried out with 3 ml of HNO₃ (65% Sigma-Aldrich Trace Metal grade) and 2 ml of hydrogen peroxide (33%, 'ultrapure' quality Merck, Darmstadt) at 100°C in a thermostated bath for 4 h. Each sample was diluted to 10 ml with 18.2 MΩ type 1 water. When fluorhydric acid was used, 1 ml of fluorhydric acid (40%, 'ultrapure' quality Merck, Darmstadt) was also used along with nitric acid and hydrogen peroxide as described previously.

Subsequently, samples were analyzed by Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES) on a Thermo Scientific iCAP 6500 (Thermo Fischer, Waltham, MA).

Leaf gas exchange and water potential measurements

Measurement of leaf gas exchange in 2011, 2012 and 2013 was determined on three plants per experimental plot using an infrared gas analyzer (LI-COR 6400 IRGA with an integrated 6400-40 leaf chamber fluorometer, Li-Cor, Inc., Lincoln, NE). Measurements were performed in the morning between 9:00 and 11:00 AM on a leaf from the middle part of the shoot. Leaves were illuminated by the LI-COR 6400 LED light source providing a photosynthetic photon flux density ca. 1000 μmol m⁻² s⁻¹. The level of CO₂ was fixed at 380 ppm within the leaf chamber. Net photosynthesis was measured when foliar CO₂ uptake was steady. Leaf water potential (MPa) was measured at midday during berry ripening on two plants per experimental plot using the Scholander pressure chamber method (Scholander *et al.*, 1965). From each vine, one mature, completely expanded, sun-exposed, healthy leaf from the eighth node was selected. Leaf gas exchange and water potential were measured at least once annually.

Leaf enzymatic activities

Samples of ten leaves from each experimental plot were collected in June and July, 2012 and 2013. We sampled fully expanded young leaves, from the 8th node in June and the 12th node in July. Each leaf sample was weighed, quickly frozen in liquid nitrogen, and immediately ground to fine powder using a pre-chilled mortar and pestle. Proteins were extracted with a chilled sodium acetate buffer, 20 mM, pH 5.5 (1 ml g⁻¹ fresh weight), containing 1% (w/v) polyvinylpyrrolidone (Sigma Chemical Co, St. Louis, MO). Extractions were carried out at 4°C for 90 min with continuous gentle stirring. Each crude extract was centrifuged twice at 12,000 g for

20 min at 4°C. The supernatant was filtered using a GV Millex[®] Syringe Filter Unit (Millipore Corporation, Billerica, MA) to remove solid particles. Protein concentrations were determined by the protein-dye-binding method (Bradford, 1976), using BSA (BioRad Laboratories, Inc., Hercules, CA) as a standard. Each enzyme activity assay was performed twice in triplicate.

Detection of 1,3-β-glucanase activity (EC 3.2.1.39)

1,3-β-glucanase activity in leaves was analyzed by measuring the rate of production of reducing sugars employing laminarin (Sigma Chemical St. Louis, MO), as the substrate and following a modified version of the procedure of Kauffmann *et al.* (1987). The reaction mixture was composed of a 0.4 ml sodium acetate buffer, 0.1 M, pH 5.2 containing 1 mg ml⁻¹ laminarin and 100 μl enzymatic solution. After 3 h incubation at 37°C, 0.3 ml of alkaline copper reagent was added (Ashwell, 1957) and the mixture was heated at 100°C for 20 min. After cooling, 0.2 ml of Nelson's chromogenic reagent was added and the absorbance was measured at 660 nm (Ashwell, 1957). Glucose and enzyme standards and substrate blanks were included. One unit of 1,3-β-glucanase activity was defined as the amount of enzyme that released 1 mg glucose min⁻¹.

Detection of chitinase activity

The activities of endochitinase (EC 3.2.1.14), β-N-acetylhexosaminidase (EC 3.2.1.52) and chitin 1,4-β-chitobiosidase (Lorito, 1998) were assayed following a modified procedure by Tronsmo (Tronsmo and Harman, 1993). The three chitinase assays were based on colorimetric determinations of p-nitrophenyl cleaved from the chitin-analogous substrates, p-nitrophenyl-β-D-N,N',N''-triaceetylchitotriose, p-nitrophenyl-N-acetyl-β-D-glucosaminide and p-nitrophenyl-β-D-N,N'-diacetylchitobiose (all from Sigma, respectively). Fifty μl of each substrate stock solution (2 mg ml⁻¹ in 50 mM acetate buffer, pH 5.0) were added to 30 μl of the crude protein extract from each sample. After incubation for 2 h in a water bath at 37°C, the reaction was stopped by adding 0.5 ml of 0.2 M Na₂Ca₃ and the absorbance was measured at 405 nm. Chitinase activities were calculated using an absorption coefficient for the p-nitrophenyl of 18.5 mM⁻¹ cm⁻¹.

Statistical analysis

Comparison of means and analysis of variance between treatments (ANOVA) of vine physiological parameters (net photosynthesis, stomatal conductance and water potential), plant productivity and number of clusters per vine were performed using SAS 6.04 software (SAS Institute, Cary, NC). Means were compared by the Student-Newman-Keuls test ($P \leq 0.05$). Bunch weight,

Table 2. Plant productivity, bunch number per plant, bunch weight at harvest from organically and biodynamically grown cv. Sangiovese vines in 2011–2013.

Year	Treatment	Productivity (kg plant ⁻¹)	Bunch (No. plant ⁻¹)	Bunch weight (kg)
2011	Organic	2.0	14	0.150
	Biodynamic	2.1	14	0.150
	Significance	n.s.	n.s.	n.s.
2012	Organic	2.6	15	0.161
	Biodynamic	2.6	15	0.160
	Significance	n.s.	n.s.	n.s.
2013	Organic	3.9	12	0.329
	Biodynamic	3.8	12	0.308
	Significance	n.s.	n.s.	n.s.

n.s., not significant.

Means followed by the same letter are not significantly different as per the Student–Newman–Keuls test, $P \leq 0.05$, (bunch number, plant productivity) and Kruskal–Wallis test, performed by Dunn's comparison test (bunch weight), $P < 0.05$.

bunch rot incidence and severity, and the Ravaz-index were analyzed using the Kruskal–Wallis non-parametric test, followed by Dunn's comparison test. Data on the activity of each enzyme were statistically analyzed by three-way ANOVA with treatment, year and month as main factors using SAS 6.04 software.

Results and Discussion

Plant parameters

Cultivation method (organic versus biodynamic) did not influence grape vegetative (pruning weight) and productive (yield) parameters (Table 2). Estimated yield was 7.64 t ha⁻¹ for the organic system and 7.14 t ha⁻¹ for the biodynamic system in 2011; 9.43 (organic) and 9.31 (biodynamic) in 2012; 13.99 (organic) and 13.39 (biodynamic) in 2013. In 2011 and 2012, the incidence of fungal diseases was negligible and was not influenced by treatments. However, in 2013, a minor incidence of bunch rot was observed during the latter part of September, but no differences in the incidence (organic: 4.3%; biodynamic 3.2%) and severity (organic: 0.8%; biodynamic: 0.7%) of *B. cinerea* were observed between cultivation methods. It is important point out that the 2011–2012 growing seasons were characterized by low rainfall, high temperatures and a general decline in plant productivity (Table 2).

Characterization of biodynamic preparations

The mineral profile of the biodynamic preparations is presented in Table 3. Both macro- and micro-elements were detected in all preparations. As expected, a high concentration of Si was found in 501, particularly when fluorhydric acid was used as extracting agent. Concerning plant regulators, the CK isopenthyll adenosine was found in the biodynamic preparation 500 (0.087 pM g⁻¹), 500 K

(0.323 pM g⁻¹) and fladen (0.238 pM g⁻¹), whereas it was below detection limits in 501. In all the investigated preparations, the concentrations of isopenthyll adenine (CK), IAA and ABA were below the detection limits.

The concentration of isopenthyll adenosine found in the biodynamic preparations, 500, 500 K and fladen, was very low when compared with the concentration of CKs used in commercial products, which typically ranges between 0.1 and 1 mg l⁻¹. Considering that application rates of CK-based foliar products are between 1 and 3 liters ha⁻¹ (0.1–3 mg CK ha⁻¹), the concentration of active CKs incorporated in soil with the biodynamic preparations (around 1.114×10^{-5} mg of isopenthyll adenosine per ha) was negligible.

We cannot ascribe observed physiological effects to a specific component of the biodynamic preparations. The extremely low amounts of plant regulators supplied by the biodynamic preparations suggest that the hormonal mode of action proposed by Stearn (1976) is unlikely. The silicon supplied by the biodynamic preparation 501 (quartz powder) may have induced some physiological effects detected in leaves, as silicon can stimulate plant resistance to biotic and abiotic stress (Ma and Takahashi, 2002; Van Bockhaven et al., 2013), but again, no direct evidence exists from this experiment for this theory. With regard to bunch rot infection in 2011–2013, no differences were observed between treatments. However, in 2010 vegetative season, characterized by frequent rainfall and elevated yields, significantly higher values were observed in organically managed experimental plots (34%) compared to the biodynamic ones (12%).

Leaf gas exchange and water potential

The application of biodynamic preparations reduced stomatal conductance in all years (reduction of 33.3, 54.7 and 90.6% in 2011, 2012 and 2013, respectively) and leaf water potential in 2012 (Table 4). Leaf photosynthetic

Table 3. Concentration of mineral elements in the biodynamic preparations.

Mineral Elements										
(a) TOC, HC, TOC/HC, N, P, K, Ca, Mg, S										
Preparation	TOC ¹ (%)	HC ² (%)	TOC/HC (%)	N (%)	P (%)	Mo (µg g ⁻¹)	Zn (µg g ⁻¹)	Mg (%)	S (%)	
500	19.60	9.90	50.00	1.93	0.43	576.60	108.00	0.66	0.35	
500 K	19.10	14.60	76.00	1.60	0.54	542.10	169.00	0.75	0.30	
Fladen	17.40	10.10	58.00	1.60	0.59	478.50	99.00	1.15	0.28	
501	0.11	n.d.	—	1.38	0.00	0.90	1.00	0.01	0.00	
501—FH ³	n.d. ⁴	n.d.	—	0.03	0.00	2.50	9.00	0.01	0.01	
(b) Na, Fe, B, Cu, Mn, Mo, Zn, Si										
Preparation	Na (%)	Fe (%)	B (µg g ⁻¹)	Cu (µg g ⁻¹)	Mn (µg g ⁻¹)	Mo (µg g ⁻¹)	Zn (µg g ⁻¹)	Si (µg g ⁻¹)		
500	0.06	1.22	29.70	45.80	576.60	1.10	108.00	37.00		
500 K	0.10	1.15	33.50	60.10	542.10	1.90	169.00	94.00		
Fladen	0.29	1.40	38.30	44.90	478.50	2.00	99.00	40.00		
501	0.01	0.01	0.00	0.30	0.90	0.00	1.00	586.00		
501—FH ³	0.03	0.01	158.80	0.40	2.50	0.00	9.00	58,944.00		

¹ Total carbon.² Humic acid carbon.³ Digested using fluorhydric acid.⁴ n.d. under limit of detection.

activity was not influenced by treatments (Table 3). One could compute water use efficiency (WUE) from these results using either gas exchange or carbon isotope ratios in leaf dry matter. In the shorter term, it is common to use leaf gas exchange measurements by relating net CO₂ assimilation rate (A_N) with stomatal conductance (g_s)—i.e., the so-called intrinsic water use efficiency ($WUE_i = A_N/g_s$) (Tomás *et al.*, 2014). The parameters A_N and g_s are involved in carbon and water economy, respectively, and in grapes, a non-linear relationship between A_N and g_s has been reported, suggesting that the diverse responses by WUE_i are mostly related to variations in g_s (Medrano *et al.*, 2012). In our study, grapevines treated with biodynamic preparations exhibited lower g_s conductance. Since photosynthetic activity was not influenced by treatments (Table 4), these results indicated a higher WUE (Chaves *et al.*, 2010) in biodynamically managed vines, a relevant physiological and agronomic feature in grape cultivation considering that irrigation is not practiced and in some cases not allowed (e.g., some Protected Designation of Origin, PDO areas). Furthermore, reduction in stomatal conductance has been associated with enhanced plant tolerance toward biotic (Zeng *et al.*, 2010) and abiotic stresses (Salazar-Parra *et al.*, 2012, 2014), which is considered to be one of the key aspects of biodynamic viticulture by its practitioners (Turinek *et al.*, 2009).

Leaf enzymatic activities

Cultivation method had a differential influence on leaf enzyme activities, including chitinases (endochitinase, β -N-acetylhexoaminidase and chitin 1,4- β -chitobiosidase) and 1,3- β -glucanase (Table 5). No significant interactions related to treatment $\times$ year and treatment $\times$ month were detected. In 2012 and 2013 years, leaf enzymatic activities were higher in plants under biodynamic management. Means from 2012 and 2013 data showed increases of 82.5, 52.3, 54.5 and 74.0%, respectively, for endochitinase, β -N-acetylhexoaminidase, chitin 1,4- β -chitobiosidase and 1,3- β -glucanase, compared with organic management. All enzymes displayed higher activity in 2012 than in 2013. Year effects were observed with 1,3- β -glucanase, whose activity in 2012 was 4.1-fold higher than in 2013.

In our experiment, the above-mentioned physiological data collected under field conditions are consistent with the enzymatic activities endochitinase, β -N-acetylhexoaminidase, chitin 1,4- β -chitobiosidase and 1,3- β -glucanase measured on leaves in the laboratory (Table 5). Differences in these enzymes were also detected between resistant and susceptible *Vitis* cultivars, including interspecific hybrids, on the order of ninefold for chitinase (from 0.18 to 1.98 cpm $\times 10^{-6}$ /h.g FWt) and sevenfold for β -1,3 glucanase (from 6.4 to 46.9 μ mol h.g FWt⁻¹) (Giannakis *et al.*, 1998). These enzymatic concentrations were differentially expressed in leaves of the two management systems, with leaves from the biodynamic system

Table 4. Net photosynthesis, stomatal conductance and water potential measured on grapevines cultivated with the organic and biodynamic methods during the vegetative growth period in the 2011–2013.

Physiological parameters			
Net photosynthesis ($\mu\text{mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$)			
Treatment	2011	2012	2013
Organic	6.91	5.98	11.47
Biodynamic	6.10	4.69	10.96
Significance	n.s.	n.s.	n.s.
Stomatal conductance ($\text{mol H}_2\text{O m}^{-2} \text{ s}^{-1}$)			
Organic	0.12 a	0.14 a	0.32 a
Biodynamic	0.08 b	0.06 b	0.03 b
Significance	*	*	*
Leaf water potential (–MPa)			
Organic	1.20	1.74 b	0.81
Biodynamic	1.32	1.96 a	0.90
Significance	n.s.	*	n.s.

n.s.;*, not significant; significant at $P = 0.05$, respectively.

Means followed by the same letter do not differ by the Student–Newman–Keuls test ($P \leq 0.05$).

Table 5. Activities of endochitinase, β -N-acetylhexosaminidase, chitin 1,4- β -chitobiosidase and 1,3- β -glucanase enzymes of grape leaves under organic and biodynamic management in 2012 and 2013.

Enzyme activity ¹				
Treatment	2012	2013	Mean	Significance
Endochitinase (U g protein ⁻¹)				
Organic	5.38	1.57	3.48 b	*
Biodynamic	9.92	2.78	6.35 a	
Mean	7.65 a	2.18 b		
Significance	***			
β-N-acetylhexosaminidase (U g protein ⁻¹)				
Organic	6.84	1.87	4.36 b	*
Biodynamic	10.26	3.01	6.64 a	
Mean	8.55 a	2.44 b		
Significance	***			
chitin 1,4-β-chitobiosidase (U g protein ⁻¹)				
Organic	7.53	2.41	4.97 b	*
Biodynamic	12.07	3.29	7.68 a	
Mean	9.80 b	2.85 a		
Significance	***			
1,3-β-glucanase (U mg protein ⁻¹)				
Organic	52.17	14.96	33.57 b	*
Biodynamic	95.91	20.95	58.43 a	
Mean	74.04 a	17.96 b		
Significance	**			

¹ One unit (U) of chitinase activity (endochitinase, β -N-acetylhexosaminidase and chitin 1,4- β -chitobiosidase) is defined as the amount of enzyme that releases 1 μM p-nitrophenyl min^{–1}; one unit of 1,3- β -glucanase activity is defined as the amount of enzyme that releases 1 mg glucose min^{–1}.

Within columns or lines, means followed by different letters differ significantly at different P levels: * $P \leq 0.05$; ** $P \leq 0.01$; *** $P \leq 0.001$.

1.52- to 1.82-fold greater for chitinases and 1.74-fold greater for 1,3- β -glucanase, compared with the organic system (Table 5).

There have been several reports of a correlation between an increase of these enzymes and reduction of

symptoms caused by *B. cinerea* (Magnin-Robert et al., 2007, 2013). Moreover, the effect of induced resistance by β -aminobutyric acid against downy mildew (*P. viticola*) (Reuveni et al., 2001) in grapes, as well as fosetyl aluminum against *Phaemoniella chlamydospora* and

Phaeoacremonium aleophilum, the main pathogens linked to esca disease, has been documented (Di Marco et al., 2011). Also polyphenols have been cited to be involved in plant resistance mechanisms against biotic stress factors (Daayf and Lattanzio, 2008). It is noteworthy that their level was higher in biodynamically grown berries compared with organically grown vines (Reeve et al., 2005). Despite these reported effects in the literature, we did not observe any direct effect of increased enzymatic activities on improved plant defenses.

Another hypothesis is that silicon, which is contained in the biodynamic quartz powder, led to a decrease in stomatal conductance, as previously shown (Gao et al., 2006), and to increase chitinase and 1,3- β -glucanase enzyme activities (Chérif et al., 1994; Dann and Muir, 2002).

Concluding remarks

Since in our experiment different biodynamic preparations were used, we are not able to distinguish among effects arising from the distinct preparations. Moreover, the observed effects on vine physiology cannot be ascribed to a specific component of the biodynamic preparation. However, it is possible that silicon supplied by the biodynamic preparation 501 (quartz powder) may have played an important role. Biodynamic theories do not claim any particular substance effect, but rather, attribute the possible influence to the entire complex of biodynamic preparations (Steiner, 1924). Additional research is needed to further ascribe causal relationships between biodynamic preparations and plant physiological effects.

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Glyphosate impacts on polyphenolic composition in grapevine (*Vitis vinifera* L.) berries and wine

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ABSTRACT

Glyphosate is the most widespread herbicide for weed management, being extensively used in viticulture. In this study we tested, under field conditions, the effects of glyphosate applications on the quality of berry and wine, from cv. Ancellotta (*Vitis vinifera* L.), with particular regard to anthocyanin concentration and composition. Ripening and growth were monitored by analyzing berry technological parameters and weight. Additionally, microvinifications were performed, in order to analyze the concentration of anthocyanins, other flavonoids and phenolic acids in wine. Our findings indicated that, at harvest, both pH and anthocyanin concentration were significantly lower and titratable acidity higher in berries collected from vines of plots under glyphosate-treatment compared with those of non-treated parcels. Data suggest that treatment with glyphosate did not change the concentration of anthocyanins, other flavonoids and phenolic acids in the wine. Our results indicate that treatment with glyphosate may affect fruit metabolism and nutritional value in non-target plants.

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1. Introduction

Glyphosate is the most widely used herbicide in the world (Global Industry Analyst, 2011). In the field, glyphosate is sprayed on target plants (weeds) foliage; however, a consistent quantity can reach the soil surface leading to contamination of non-target plants (Tesfamariam, Bott, Cakmak, Römhild, & Neumann, 2009). Moreover, it has been suggested that exudation from the roots of sprayed plants and the release from dead plants can be sources of glyphosate to adjacent plants (Coupland & Caseley, 1979; Neumann et al., 2006). The herbicidal effect of glyphosate can be ascribed to the inhibition of the 5-enolpyruvylshikimate-3-phosphate synthase (EPSPs), an enzyme of the shikimate pathway, blocking the biosynthesis of the amino acids phenylalanine, tyrosine and tryptophan (Siehl, 1997). The blockage of the shikimate pathway results in substantial accumulation of shikimate in plant tissues provoking a decrease of flavonoid and lignin concentrations (Franz, Mao, & Sikorski, 1997; Olesen & Cedergreen, 2010). It is interesting to mention that, despite the shikimate pathway being

absent in mammals, glyphosate is capable of blocking this metabolic route in gut bacteria, which play an important role in human physiology (Samsel & Seneff, 2013). Consequences include gastrointestinal disorders, obesity, diabetes, cancer, heart disease and Alzheimer's disease.

Glyphosate has several indirect effects on plant physiology, which may also explain its herbicidal effectiveness. First of all, glyphosate is easily bound to divalent cations by its carboxyl and phosphonate groups, forming very stable complexes and leading to immobilization of several cations in both soil and plant tissues (Cakmak, Yazici, Tutus, & Ozturk, 2009). As a metal chelator, glyphosate also causes decrease in the availability of nutrients, which have important roles as enzymatic co-factors or constituents of antioxidative systems in plants (Cuypers, Vangronsveld, & Clijsters, 2001). The effects of glyphosate on carbon and nitrogen metabolism have also been studied (Orcaray, Zulet, Zabalza, & Royela, 2012; Zobiole et al., 2010). Glyphosate can be quickly degraded to aminomethylphosphonic acid (AMPA) by microorganisms in the soil (Van Eerd, Hoagland, Zablutowicz, & Hall, 2003), and a similar degradation has been proposed in plants (Reddy & Zablutowicz, 2003); therefore the co-presence of glyphosate and AMPA can be expected in plant tissues.

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In sunflower, glyphosate exposure can reduce seed production and quality (Teschmariam et al., 2009). However, little information is available about the indirect effects of foliar treatment with glyphosate on edible organs and transformed products. Rosenberger, Watkins, Sazo, Kahle, and Nock (2010) reported that canopy exposure at extremely high glyphosate concentration increased the incidence and severity of internal browning of apple fruits during long-term storage in controlled atmosphere.

To date, no studies have evaluated the effects of glyphosate, on fruit polyphenol composition when it directly comes into contact with non-target plants, through soil surface contamination. For the purpose of this study, we selected, as a model plant, the *Vitis vinifera* cv. Ancellotta, a red variety rich in anthocyanins (Mattivi, Guzzon, Vrhovsek, Stefanini, & Velasco, 2006; Simone et al., 2013) and therefore highly prized for its dense pigmentation. Indeed, cv. Ancellotta grapevines are extensively cultivated in the Emilia-Romagna Region of Italy, being used mainly as secondary grape (color-booster) to enhance the red color of Lambrusco wines, in which it may constitute up to 15% of the blend (DM MIPAAF, 30.11.2011).

We assessed the influence of glyphosate application on the quality of grapes and wine from cv. Ancellotta, grown under field conditions, with particular regard to anthocyanins concentration and composition.

2. Materials and methods

2.1. Plant material and growth conditions

The experiment was performed in 2008, in a mature vineyard, planted in 1994, with cv. Ancellotta (clone 13) grafted on K5BB. The vineyard was located in Tebano (Ravenna, Italy), 44°17'30.2" N, 11°47'01.4" E, 110 m a.s.l., on a mild hill slope, with South-East/North-West and downhill oriented rows. Vines were spaced 1.5 m apart within the row and 3 m between rows (planting density = 2222 plants ha⁻¹), spur-pruned (20 nodes per vine) and trained according to the free cordon system.

Overall, the vegetative season was characterized by average temperatures of 20.1 °C during the period of observation (April–September), with maximum daily averaged temperature of 27.5 °C in August. From bud burst (first week of April), to harvest (September 11th), the average relative humidity (RH) varied from 50% to 83%; the highest values were observed during April and May (100%) and the lowest in August (20%). The total rainfall from bud burst to harvest (257 mm) occurred mainly in the period April–June.

Pest management was carried out according to Integrated Pest Management Practices (IPM) of the Emilia-Romagna Region.

2.2. Soil management treatments

Two soil management treatments were compared: i) superficial tillage (ST) up to 5–10 cm in depth, carried out twice, with the first time being in spring (April 9th) and the second time in summer (July 16th); and ii) glyphosate application (GA), in the form of isopropylamine salt (2.4 kg ha⁻¹) supplied by the commercial product "Roundup®Bioflow" applied to the row by covering a strip 80 cm wide, three times during the vegetative season, once in spring (April 8th) and twice in summer (July 17th and August 29th). The treatment was applied by avoiding direct contact between glyphosate and the vines. The targeted weeds included dicotyledonous and monocotyledonous.

Both treatments (glyphosate application and superficial tillage) were applied to four replicates, each consisting of two plants in a

completely randomized design. Plants were located in two adjacent rows.

The different soil management treatments in a row strip were applied on alternate rows. In order to avoid contact between the roots of plants submitted to the two different treatments and possible exchanges of glyphosate or AMPA among them, two soil cuts were made at a depth of 70–80 cm parallel to the row in the center of the alley.

2.3. Berry growth and technological parameters

The following parameters were analyzed: berry weight, expressed as g per berry (technical balance Gibertini Elettronica S.r.l., Milan, Italy), total soluble solids (TSS; Brix; Electronic Refractometer Maselli Misura S.P.A., Parma, Italy), titratable acidity (TA; expressed as g/L of tartaric acid) and pH (Crison Compact Titrator, Crison Instrument SA, Barcelona, Spain). These parameters were periodically determined by collecting 50 berries per replicate since veraison until harvest.

2.4. Anthocyanin concentration and composition in berry skins

Additional samples were collected at harvest for determining anthocyanins qualitative and quantitative profile. For each treatment, four replicates, constituted of twenty berries, were collected from two plants. Anthocyanins from the skin were extracted according to Mattivi et al. (2006). Grape extract from each sample was analyzed according to Mattivi et al. (2006), using an Ekeran HPLC apparatus (Waters) equipped with a PDA detector and a reversed-phase column (LiChrospher 100, RP-18, 250 × 4 mm, Sigma-Aldrich). Anthocyanins were determined by measuring absorbance at 520 nm. A calibration curve was established with malvidin-3-glucoside standard (Sigma-Aldrich; Milan, Italy) and the anthocyanins were expressed as mg/g skin.

2.5. Microvinification process

In order to evaluate the effects of soil management treatments on phenolic acids, flavonoids and anthocyanins composition of wine, four microvinifications were carried out for each treatment according to Sampaio, Kennedy, and Vasconcelos (2007). Grapes were harvested on September 12th, 2009. Five kilograms of grape were destemmed and crushed, then transferred to a microfermentor (5 L cylindrical glass container, covered with aluminum foil to limit the effect of the light) equipped with a fermentation airlock. Must and pomaces were added with a little amount of carbon dioxide, potassium metabisulfite (SO₂, 0.25 g container⁻¹, corresponding to 50 ppm for microbial control), a complex nutrient containing ammonium sulfate, bibasic ammonium phosphate and thiamine (30 g h L⁻¹, Nutriferm start, Enartis, Trecate, NO, Italy) and yeast "ex 404" (1 g container⁻¹). Fermentation took place at 20 °C. The racking off was carried out when the analysis showed reducing sugar content ranging from 0 to 2.5 g L⁻¹ (Lane & Eynon, 1923), and the container weight (measured every two days) remained constant for 5 days. Afterwards, wine was clarified by means of bentonite (40 g h L⁻¹ 1:10 dilution) and combined with SO₂ up to 100 g L⁻¹. Then, wines were allowed to cool for thirty days at -4 °C for cold stabilization, then stored at 4–5 °C until the polyphenols analyses. Average data from four vinification per treatment are reported.

2.6. Phenolic acid and flavonoid concentration and composition in wine

An High Performance Liquid Chromatography (HPLC) system equipped with temperature control oven, photodiode array

detector (DAD) and a Chromeleon chromatography manager software v. 6.60 SP2 (Dionex DX500, Milano, Italy) was used for identification and quantification of anthocyanins, phenolic acids and flavan-3-ols. The samples were always filtered using 0.20 µm cellulose acetate membrane (Millipore, Milano, Italy) before direct injection into the HPLC system and kept at 30 °C. The analysis of phenolic acids and flavan-3-ols was carried out according to Castellari, Sartini, Fabiani, Arfelli, and Amati (2002), using a reverse-phase C18 column (Chromolith Performance RP 18, 100 mm × 4.6 mm, Merck, Readington Township, USA) with eluting conditions consisting in a multistep gradient (methanol: 2.5/97.5 v/v; water: 50/50 v/v), measuring the absorbance at different wavelengths (256, 280, 308, 324, 365 nm). Quantification was made using calibration curves obtained by standard solutions of simple phenols and phenolic acids under examination. The anthocyanins qualitative and quantitative analyses were carried out based on Arfelli, Chiavari, Castellari, and Amati (1992) using a reverse-phase C18 column (Hypersil RP-18, 250 mm × 4.6 mm Thermo Scientific, Waltham, MA USA) and a binary gradient (methanol/water 30/70 v/v; methanol/water (75/25 v/v) both added with 6 mL L⁻¹ of perchloric acid 70%). Analysis was carried out at 530 nm. Concentrations were calculated according to a calibration curve obtained using malvidin-3-glucoside as a standard (Sigma-Aldrich, Milan, Italy).

2.7. Statistical analysis on berries and wine parameters

Mean differences in chemical composition of grape and wines were ascertained by one-way analysis of variance (ANOVA), using SAS 6.04 software (SAS Institute, Cary, NC, USA). All statistics were performed with significance at $P = 0.05$.

3. Results

3.1. Berry ripening parameters

Treatments did not affect the weight of the fresh berry and total soluble solids concentration during ripening (Table 1). The berry

juice pH and titratable acidity provided similar results from both treatments with the exception of the last sampling date (September 11th), when the pH values of berries from plants subjected to glyphosate application were lower and the titratable acidity values higher than those of berries from vines of parcels managed by superficial tillage (Table 1).

3.2. Anthocyanins concentration and composition in berry skins

Various anthocyanins were identified in the berry skins (Table 2). Non acylated monoglucoside anthocyanins predominate over acetylglucosidated and p-coumarilglucosidated forms. Among glucosidated forms, malvidin-3-glucoside was the prevalent anthocyanin, followed by delphinidin-3-glucoside, petunidin-3-glucoside, peonidin-3-glucoside and cyanidin-3-glucoside, in accordance with what was observed by Mattivi et al. (2006) and Simone et al. (2013). Tri-hydroxylated (3',4',5'-OH) and di-hydroxylated forms (3',4'-OH) represented respectively 90.3% and 9.7% of total 3-glucosidated anthocyanins in berry skins from parcels subjected to glyphosate treatment, while 88.9% (3',4',5'-OH) and 11.1% (3',4'-OH) were present in berries sampled in plots managed by superficial tillage. Lower concentrations of both 3',4',5'-OH (ST: 9.18 mg g⁻¹ skin; GA: 8.47 mg g⁻¹ skin) and 3',4'-OH (ST: 1.17 mg g⁻¹ skin; GA: 0.91 mg g⁻¹ skin) were detected in berries from vines of parcels treated with glyphosate. Malvidin-3-O-(6"-acetylglucoside) and peonidin-3-O-(6"-acetylglucoside) were the major acylated anthocyanins (Table 2). Among p-coumarilglucosidated forms, malvidin, delphinidin and peonidin were detected and identified (Table 2).

Grapes from vines cultivated under glyphosate application exhibited significantly different concentrations of some anthocyanins. In particular, delphinidin-3-glucoside and peonidin-3-glucoside were significantly lower in berry skins from glyphosate-treated parcels (Table 2). In addition, the concentration of berry skin acylated anthocyanins was affected in the same plots, showing a significant decrease in delphinidin-3-O-(6"-acetylglucoside), cyanidin-3-O-(6"-acetylglucoside) and petunidin-3-O-(6"-acetylglucoside) concentrations, compared to those of berries sampled in plots managed by superficial tillage (Table 2). No difference

Table 1
Weight of the fresh sample (g), technological parameters (total soluble solids, Brix; pH; titratable acidity, g L⁻¹ of tartaric acid) recorded during ripening, in berries of cv. Ancellotta grapevines collected from plots subjected to superficial tillage or glyphosate application (n = 4).

Treatments	Sampling date				
	Jul/28	Aug/08	Aug/19	Aug/24	Sep/11
Fresh weight					
Superficial tillage	0.96 ± 0.07	1.43 ± 0.18	1.39 ± 0.09	1.42 ± 0.08	1.35 ± 0.12
Glyphosate	0.97 ± 0.06	1.35 ± 0.05	1.33 ± 0.10	1.39 ± 0.09	1.34 ± 0.07
Significance	n.s.	n.s.	n.s.	n.s.	n.s.
F-Value	0.03	0.74	1.01	0.29	0.03
Total soluble solids					
Superficial tillage	10.0 ± 0.4	15.1 ± 0.6	18.5 ± 1.1	21.6 ± 1.2	26.2 ± 0.9
Glyphosate	10.5 ± 0.4	15.6 ± 0.5	19.6 ± 1.1	21.7 ± 0.7	25.8 ± 1.6
Significance	n.s.	n.s.	n.s.	n.s.	n.s.
F-Value	3.00	1.60	1.94	0.01	0.17
Berry juice pH					
Superficial tillage	2.69 ± 0.02	3.01 ± 0.04	3.13 ± 0.05	3.29 ± 0.04	3.66 ± 0.01
Glyphosate	2.68 ± 0.02	2.96 ± 0.02	3.16 ± 0.03	3.28 ± 0.02	3.48 ± 0.02
Significance	n.s.	n.s.	n.s.	n.s.	*
F-Value	0.47	2.94	0.82	0.17	11.97
Titratable acidity					
Superficial tillage	15.8 ± 1.1	14.9 ± 1.4	10.4 ± 0.9	8.5 ± 0.8	6.0 ± 0.1
Glyphosate	15.3 ± 1.0	15.2 ± 1.1	10.5 ± 0.6	8.5 ± 0.4	6.4 ± 0.2
Significance	n.s.	n.s.	n.s.	n.s.	*
F-Value	0.47	0.09	0.07	0.00	19.75

n.s.: not significant.

* Significant ($P = 0.05$).

Table 2

Anthocyanins composition and concentration (mg g⁻¹ fresh skin) in berries of cv. Ancellotta from parcels subjected to superficial tillage or glyphosate application (n = 4).

Anthocyanins	Superficial tillage	Glyphosate	Significance	F-value
Df-3-glc	3.07 ± 0.11	2.61 ± 0.17		14.47
Cn-3-glc	0.45 ± 0.23	0.31 ± 0.07	n.s.	2.01
Pt-3-glc	1.99 ± 0.32	1.80 ± 0.32	n.s.	1.13
Pn-3-glc	0.72 ± 0.08	0.60 ± 0.05		19.89
Mv-3-glc	4.11 ± 0.20	4.06 ± 0.58	n.s.	0.04
Total-glc	10.35 ± 0.96	9.39 ± 1.10		3.19
Df-acetylglc	0.49 ± 0.04	0.41 ± 0.03		25.39
Cn-acetylglc	0.08 ± 0.02	0.05 ± 0.01		10.22
Pt-acetylglc	0.38 ± 0.01	0.33 ± 0.03		12.68
Pn-acetylglc + Mv-acetylglc ^a	1.21 ± 0.04	1.22 ± 0.16	n.s.	0.01
Total-acetylglc	2.16 ± 0.11	2.01 ± 0.21	n.s.	4.05
Df-coumaroylgc	0.26 ± 0.02	0.26 ± 0.25	n.s.	0.03
Pn-coumaroylgc + Mv-coumaroylgc ^a	0.74 ± 0.05	0.82 ± 0.17	n.s.	0.73

Df: delphinidin; Cn: cyanidin; Pt: petunidin; Pn: peonidin; Mv: malvidin; glc: glucoside; acetylglc: 3-O-(6"-acetylglucoside); coumaroylgc: 6-O-(p-coumaroyl)-glucoside. n.s.: not significant.

^a Significant (P = 0.05).

^a The peaks associated to these two compounds did not separate completely.

was observed for the sum of peonidin-3-O-(6"-acetylglucoside) and malvidin-3-O-(6"-acetylglucoside) nor for the concentration of 6-O-(p-coumaroyl)-glucoside anthocyanins (Table 2).

3.3. Anthocyanins, other flavonoids and phenolic acids in wine

Glyphosate did not induce a significant effect on anthocyanins, other flavonoids and phenolic acids concentration in wine (Tables 3 and 4). In both wines the phenolic profile was typical of cv. Ancellotta (Ragone et al., 2015) and characterized by high concentration of malvidin-3-glucoside (362 ± 29 vs 362 ± 27 mg L⁻¹), delphinidin-3-glucoside (121 ± 23 vs 122 ± 19 mg L⁻¹) and petunidin-3-glucoside (112 ± 20 vs 112 ± 15 mg L⁻¹). The most representative among the 3-O-(6"-acetylglucoside) was malvidin (80.0 ± 5.2 vs 81.8 ± 7.2 mg L⁻¹), whereas the petunidin 6-O-(p-coumaroyl)-glucoside had the highest concentration among p-coumaroyl derivatives. With respect to phenolic acid and flavonoid composition (Table 4), wines were similar regardless of soil man-

Table 3

Anthocyanins (mg L⁻¹) in wines of cv. Ancellotta obtained from parcels subjected to superficial tillage or glyphosate application (n = 4).

Anthocyanins	Superficial tillage	Glyphosate	Significance	F-value
Df-3-glc	121 ± 23	122 ± 19	n.s.	0.01
Cn-3-glc	9.7 ± 0.5	7.2 ± 1.2	n.s.	0.43
Pt-3-glc	112 ± 20	112 ± 15	n.s.	0.00
Pn-3-glc	29.8 ± 10.8	27.0 ± 3.5	n.s.	0.24
Mv-3-glc	362 ± 29	362 ± 27	n.s.	0.00
Df-acetylglc	26.4 ± 2.9	28.2 ± 3.9	n.s.	0.56
Cn-acetylglc	5.5 ± 0.2	5.2 ± 0.4	n.s.	1.40
Pt-acetylglc	29.2 ± 2.3	29.9 ± 3.7	n.s.	0.11
Pn-acetylglc	9.3 ± 1.0	9.1 ± 0.9	n.s.	0.12
Mv-acetylglc	80.0 ± 5.2	81.8 ± 7.2	n.s.	0.17
Df-coumaroylgc	11.7 ± 1.2	13.2 ± 2.3	n.s.	1.32
Cn-coumaroylgc	3.1 ± 0.3	3.4 ± 0.3	n.s.	1.50
Pt-coumaroylgc	11.1 ± 1.2	12.4 ± 1.8	n.s.	1.46
Pn-coumaroylgc + Mv-coumaroylgc ^a	40.0 ± 4.5	42.9 ± 4.4	n.s.	0.95

Df: delphinidin; Cn: cyanidin; Pt: petunidin; Pn: peonidin; Mv: malvidin; glc: glucoside; acetylglc: 3-O-(6"-acetylglucoside); coumaroylgc: 6-O-(p-coumaroyl)-glucoside. n.s.: not significant (P = 0.05).

^a The peaks associated to these two compounds did not separate completely.

Table 4

Phenolic acids and flavonoids (mg L⁻¹) in wines of cv. Ancellotta obtained from parcels subjected to superficial tillage or glyphosate application (n = 4).

Phenolic acids and flavonoids	Superficial tillage	Glyphosate application	Significance	F-value
Gallic acid	15.1 ± 1.9	15.7 ± 2.0	n.s.	0.17
Catechin	38.9 ± 3.9	39.2 ± 8.1	n.s.	0.00
Epicatechin	51 ± 11	42 ± 19	n.s.	0.65
Protocatechuic acid	3.5 ± 0.6	3.1 ± 0.5	n.s.	0.84
Cutric acid	20.7 ± 2.7	21.1 ± 2.4	n.s.	0.05
Caftaric acid	87 ± 11	87.2 ± 5.7	n.s.	0.00
Rutin	7.8 ± 1.9	9.6 ± 1.7	n.s.	2.08
Myricetin	3.7 ± 0.1	3.7 ± 0.3	n.s.	0.06
Quercetin	3.8 ± 0.4	4.0 ± 0.5	n.s.	0.36
Total	231 ± 23	225 ± 35	n.s.	0.08

n.s.: not significant (P = 0.05).

agement treatment. In both wines, high concentration of catechin (38.9 ± 3.9 vs 39.2 ± 8.1 mg L⁻¹), epicatechin (51 ± 11 vs 42 ± 19 mg L⁻¹) and caftaric acid (87 ± 11 vs 87.2 ± 5.7 mg L⁻¹) were detected, whereas the others phenolics ranged between 3.1 and 15.7 mg L⁻¹.

4. Discussion

Glyphosate is one of the most effective and extensively used herbicides in vineyards (Busse, Ratcliff, Shestak, & Powers, 2001; Service, 2007). Despite the growing interest, there is little information on the effects and quantification of glyphosate on fruits and thereby on products for human consumption. Moreover, the quantitative determination of glyphosate at trace levels in foods is difficult, depends on the matrix (Simonetti, Cartaud, Quinn, Marotti, & Dinelli, 2015; Steinborn et al., 2016). Regardless of the persistence of glyphosate in the vegetal tissues, its metabolic effects are well known and described in the literature. It has been shown that glyphosate can be released into the rhizosphere of target plants and then absorbed by non-target plants (Neumann et al., 2006), provoking deleterious impacts on plant and seed growth and quality (Tesfamariam et al., 2009).

To our knowledge, this is the first report evaluating the effects of glyphosate application in the field on the phenolic composition of berries in non-target plants.

The specific inhibitory effect of glyphosate on phenylpropanoid metabolism (Siehl, 1997) may contribute to explain the lower concentration of anthocyanins in grapes from vines indirectly exposed to glyphosate (Table 2). In fact, anthocyanins are synthesized in the shikimate pathway (Castellarin, Bavaresco, Falginella, Van Zeller Gonçalves, & Di Gaspero, 2012) and glyphosate depresses anthocyanins synthesis (Holländer & Amrhein, 1980).

Here, grapes from plants grown under glyphosate applications exhibited lower concentration of some of the detected anthocyanins, mainly acylated (Table 2). The red color is a complex attribute, which is mainly function of the accumulation of anthocyanins, although is also influenced by the distribution of individual anthocyanins, and the formation of metal complexes of anthocyanins (Hondo et al., 1992).

The decrease of berry juice pH observed at harvest in plants of plots under glyphosate application (Table 1) may be attributable to a diminished uptake of cations (Bellaloui, Reddy, Zablotowicz, Abbas, & Abel, 2009; Cakmak et al., 2009; Zobiole, Kremer, Oliveira, Constantin, & Oliveira, 2011) in plants cultivated under glyphosate application and consequently to the lowest level of organic acids salification.

Moreover, data reported in Table 1 (berry juice pH and titratable acidity) suggest that, in the fruits of these vines, an enhanced synthesis of organic acids occurs, as a consequence of the inhibi-

tion of the shikimate pathway by glyphosate. In fact, the ability of glyphosate to inhibit the enzyme EPSPS is well documented (Duke et al., 2012; Means & Kremer, 2007).

However, the proposed hypothesis of a metabolic shift from secondary to primary metabolism needs to be proved by properly assessing the effects of glyphosate on organic acids composition and concentration.

Despite the differences in anthocyanin patterns detected in this study among grapes of vines from the two different weed management treatments, the HPLC-analysis of wine samples obtained through microvinification did not reveal significant differences in any of the analyzed parameters (Table 4). It is noteworthy that data from wine may be influenced by the maceration conditions and the mechanical processes (Sacchi, Bisson, & Douglas, 2005; Casassa & Harbertson, 2014).

However, it might also be worthwhile to assess the possible adverse effects of glyphosate application on other food products and beverages, such as fruit juices. For example, cv. Ancellotta itself is utilized to produce unfermented grape juices ("saba"), being characterized by a very high anthocyanin concentration and a high relative amount of antioxidant anthocyanins (Simone et al., 2013).

In conclusion, our data suggest that field treatments with glyphosate may exert a negative impact on fruit composition. If these changes are found in a cultivar rich in anthocyanins, it might be useful to know what happens to other light-colored varieties, such as Sangiovese, or other edible fruits widely known for their antioxidant proprieties.

These aspects should be further investigated, in order to reconcile sustainability and food security.

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Anexo 2:

Material audiovisual recopilado en la gira de innovación:

Ver los siguientes links:

<https://drive.google.com/file/d/0B1p4BqYUhXmJOWwwM3IGNIJBUzA/view>

<https://drive.google.com/file/d/0B1p4BqYUhXmJeXJuRzI2T0EyU0U/view>

Nota: Los videos además han sido grabados en un pendrive adjunto.

Anexo 3:

Lista de participantes de la actividad de difusión,
indicando nombre, apellido, entidad donde trabaja,
teléfono, correo electrónico y dirección.



LISTA ASISTENCIA PRIMERA CHARLA DE DIFUSION DE LA GIRA FIA

“Sistema Biodinámico de Producción para Berries y Cerezo Desarrollado en el Marco de un Modelo Comercial de Exportación de Comercio Justo (Fairtrade) en el Centro-Norte de Italia

FECHA: VIERNES - 29/JULIO/2016. FACULTAD AGRONOMIA. UFRO. TEMUCO

Nº	Nombre	Correo Electrónico	Firma
1	Emilio Monsolve		
2	Jorge Baraona Veng		
3	Pablo Aedo Mora		
4	Alvaro Contreras		
5	Karen Huergueta C.		
6	Jon M. J. L. L. Contreras		
7	Roberto Newman C.		
8	Rayen Millaleo M.		
9	Fulgencio León		
10	Emilio Jarama		
11	Alexandra Rivera		
12	María Paz Vázquez		
13	Gustavo Ciudad		

Lista de Asistencia

Charla de difusión de resultados de la Gira de Innovación FIA: "Sistema Biodinámico de Producción para Berries y Cerezo Desarrollado en el Marco de un Modelo Comercial de Exportación de Comercio Justo (Fairtrade) en el Centro-Norte de Italia", dictada por la coordinadora técnica de la Gira

Miércoles 03 de agosto de 2016 -11:00 horas en el Salón de Actos de la Universidad de La Frontera Sede Malleco, Avenida Libertador Bernardo O'Higgins 050, Angol, Chile.

N°	Nombre	Ocupación/ Empresa	Fono o email
21	Mama Riquelme	Productora Viveros	
22	Patricia Aguilar	Gerente Comercial	
23	JAI ME MEDINA PASUAL	M. VETERINARIO CAPACITEC	
24	Rubén Vergara B	Productor Cerezo	
25	CRISTIAN SERENINTEZ	ASESOR	
26	HERMINDA DIAZ M.	AGRICULTOR	
27	RENE SALAS BUSTOS	ING. AGRONOMO	
28	Pablo VAN DER MOLEN	Ag. Valle Verde	
29	Francisco Medina	- -	
30	Felix Van der Meulen	Agrícola Don Jorale	
31	Laura Prieto C.	" "	
32	Victor Fuentes Fuentes	ESI INDAP	
33	Hernán A. Gómez	Apoyo P. Viveros Celis	
34	Hernán Fuentes	J. AREA INDAP	
35	Manuel Godoy H.	E. Per. Indap. Mod	
36	Manuel Cruz D.	Capacitec	
37	Cristian Ortiz O	Asesor Hortícola	
38			
39			
40			

NOMINA ASISTENCIA

Tema : Charla Difusión Gira FIA en Producción Biodinámica de Frutales

Profesional : Pablo Aedo Mora

Fecha : Viernes, 05 de agosto de 2016

Area : Loncoche - Pitruquén

NOMBRE ASISTENTE

- 1.- PABLO BURGOS GARCES
- 2.- CRISTIAN MIEVILLE BERNAL
- 3.- Jorge Alberto Abanto
- 4.- Rodrigo Aedo A.
- 5.- Yolanda Leal Muñoz
- 6.- Victor Aníbal González
- 7.- VICTORINO VASQUEZ P.
- 8.- Manuel José Fuentes
- 9.- Juan Pablo López D.
- 10.- Alex Ceballos Fajardo
- 11.- Soledad Riffa Pimentel
- 12.- Janet Llorente
- 13.- ADEMIL R. VALARDO
- 14.- MARISOL ABANTO
- 15.- Carlos Bora
- 16.- Maria J. Rivera
- 17.- Elia Hobcock Lopez
- 18.- Javiera Diez

19. *Blondini José Rivas*

20. *Lo D. G. P. M. A.*

21. *Juan M. C. C. C.*

22. *José P. C. C. C.*

23. *Juan Sepúlveda*

24. *OSCAR ALONSO*

25. *Doroteo S. C.*

26. *Héctor S. C.*

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LISTA DE ASISTENCIA

Charla de difusión de resultados de la Gira de Innovación FIA: "Sistema Biodinámico de Producción para Berries y Cerezo Desarrollado en el Marco de un Modelo Comercial de Exportación de Comercio Justo (Fairtrade) en el Centro-Norte de Italia", dictada por la coordinadora técnica de la Gira.

Miércoles 10 de agosto de 2016, 10:30 horas, Salón Auditorium del Campus Villarrica - Pontificia Universidad Católica de Chile, Bernardo O'Higgins 501, Villarrica, Chile.

N°	Nombre	Ocupación/ Empresa	Fono o email
1	Luciano Sorobello	Perceptor A	
2	Piero Parna M	Arandano	
3	Luis Muñoz	Arandano	
4	Roberto Jaramila	Arandano	
5	Juan Borja C	Productor	
6	MARQUE SAN MARTIN	PRODUCTOR	
7	Jerson Glauser C.	Ing Agrícola	
8	Nicolás González	Ayudante	
9	Francisco Glauser	Huerto Berries	
10	Samuel Antimilla	Productor Frambuesa	
11	Pablo Acosta Mora	CAPACITEC LSA	
12	BERNARDO FIGUEROA	FIA	
13	ADRIANA PEÑA PEÑA	PRODUCTORA	
14	Maria Bernio	Productora	
15			
16			
17			
18			
19			
20			

Anexo 4:

Material entregado en las actividades de difusión



Difusión de Gira de Innovación 2016

“Sistema Biodinámico de Producción para Berries y Cerezo Desarrollado en el Marco de un Modelo Comercial de Exportación de Comercio Justo (Fairtrade) en el Centro-Norte de Italia”



10 de Agosto de 2016

f t www.fia.cl



DELEGACIÓN GIRA INNOVACIÓN AL CENTRO-NORTE DE ITALIA

Marcelo Luna Angulo

Gerente General
Capacitec Ltda.



Dra. Alejandra Ribera Fonseca (Coordinadora)

Departamento de Producción Agropecuaria
Universidad de La Frontera



Pablo Aedo Mora

Asesor Técnico en producción limpia de Frutales
Gerente Técnico de Capacitec Ltda.



Dr. Rodrigo Neculman Cerda

Investigador
Jefe de Proyectos I+D+i en producción limpia hortofrutícola
Capacitec Ltda.



DELEGACIÓN GIRA INNOVACIÓN AL CENTRO-NORTE DE ITALIA

EMPRESA + SECTOR PRODUCTIVO + UNIVERSIDAD (INVESTIGACIÓN)



25 DE JULIO A 01 DE AGOSTO DE 2016

DELEGACIÓN GIRA INNOVACIÓN AL CENTRO-NORTE DE ITALIA

LOS PRODUCTORES



Cristian Mievile Bernal

Agricultor y productor de arándano y avellano europeo de la zona de Gorbea.

Juan Pablo Alvarez Doyharcabal

Productor y Viverista de Cerezo de la zona de Gorbea.

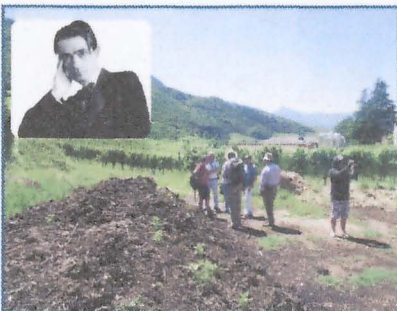


Pedro Burgos Garcés

Productor de arándano de la zona de Gorbea.

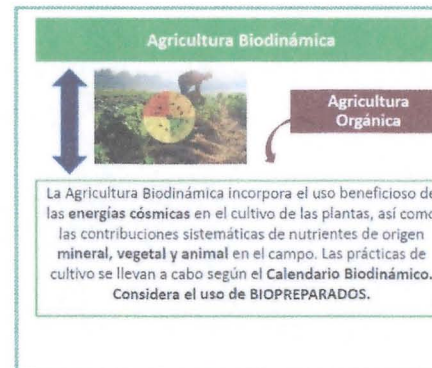
¿Qué es la Agricultura Biodinámica?

La Agricultura Biodinámica fue desarrollada por el filósofo **Rudolf Steiner** (1861-1925) y, a diferencia de la Agricultura Orgánica, se basa en el concepto de que la tierra, las plantas, los animales y el hombre trabajan conjuntamente como un **organismo agrícola**.



La producción biodinámica incluye el **uso de biopreparados**.

Lo **dinámico** se refiere a las fuerzas, cuyo ámbito se extiende a las fuerzas solares, lunares, planetarias y zodiacales, las cuales son captadas por las plantas y los animales y pueden ser observadas y conocidas por el hombre.



Curso de Formación en Agricultura Biológica Dinámica

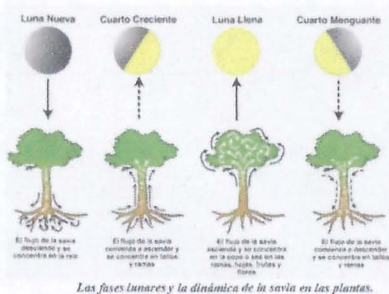
Germinan las plantas en lo profundo de la Tierra.
Brotan las hierbas por el poder del Aire.
Maduran los frutos con la fuerza del Sol.
Así germina el Alma en el fondo del Corazón.
Así brota el poder del Espíritu a la luz del mundo.
Así madura la Fuerza del hombre al resplandor Divino.
R. Steiner

Dictado en 2 años
4 Módulos de 2 semanas
Con prácticas intermodulares

Modulo 1 parte A
14 al 19 de Julio de 2014
Granja "El Sauzal", Cauquenes

Valor \$2.880.000 (\$3.600.000 empresas) todo el curso.
Varias opciones de pago, incluye comidas y alojamiento.
Cupos limitados, inscripciones en abdechile@gmail.com

Organiza Asociación de Agricultura Biológica Dinámica de Chile
ABOChile A.C.



¿Qué es la Agricultura Biodinámica?



¿Qué es Comercio Justo o "Fairtrade"?

Es una forma de comercio que se basa en establecer alianzas entre productores y consumidores, ofreciendo a **los productores un mejor trato y mejores términos de intercambio**.



Representa **una alternativa al comercio tradicional**, el cual incorpora **valores éticos** y que ofrece **productos de calidad** que son **respetuosos de medio ambiente** a un **precio justo**.

Permite al productor vivir con **dignidad** y asegurar sus **necesidades básicas**.

Se orienta a fortalecer a los productores de pequeñas unidades económicas que se apoyan en la **asociatividad y la cooperación entre productores y consumidores**, contribuyendo a la construcción de un **desarrollo más inclusivo y sustentable**.

La Génesis de la Gira



Objetivos de la Gira de Innovación



- ✓ Capturar tecnologías y estrategias para la producción biodinámica de especies frutícolas de importancia económica para la Región de La Araucanía, tales como cerezo y arándano.
- ✓ Capturar información respecto a la obtención y comercialización de productos hortofrutícolas bajo la categoría *Fairtrade* (Comercio Justo), apuntando a aumentar en forma significativa el valor de exportación de los mismos en el mercado internacional.
- ✓ **Sentar las bases para la postulación futura a proyectos I+D+i** orientados a mejorar la capacidad y calidad productiva de los fruticultores (pequeños y medianos) de la Región.

Ciudades y Localidades visitadas



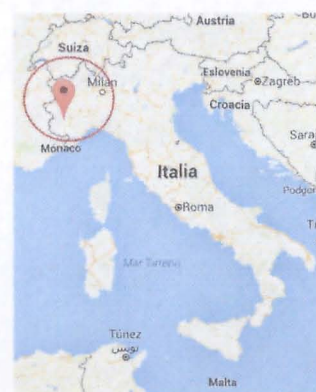
Región de Piamonte:
Saluzzo (AGRIFRUTTA)

Región de Trentino:
Trento
San Michelle All' Adige

Región de Emilia-Romagna:
Bologna
Monteveglia
Vignola
Faenza

Visita a Agrifrutta Soc. Cop. Agrícola, Región de Piamonte, Saluzzo, Italia

AGRIFRUTTA SOC. COP. AGRICOLA
16/Bis, Frazione Colombaro Rossi - 12037 Saluzzo (CN)
tel. 0171 455902, 0171 410246
Categoría: Frutta e verdura - gruppo



Nombre responsable: Claudio Baudino
Especies cultivadas: Berries (Frambuesas, Arándanos, Frutillas) para producción en fresco.
Superficie cultivada: 1000 ha diversas especies, 150 productores
Innovación: Prácticas de Producción Sustentable de Berries. Uso de Cubiertas de Protección para lluvias y granizos para Berries.

Visita a Agrifrutta Soc. Cop. Agricola, Región de Piamonte, Saluzzo, Italia



Visita a Agrifrutta Soc. Cop. Agricola, Región de Piamonte, Saluzzo, Italia.



Visita a Agrifrutta Soc. Cop. Agricola, Región de Piamonte, Saluzzo, Italia



Visita a Agrifrutta Soc. Cop. Agricola, Región de Piamonte, Saluzzo, Italia.



Visita a Agrifrutta Soc. Cop. Agricola, Región de Piamonte, Saluzzo, Italia



Visita Region del Trentino, San Michele All'adige, Trento

- ✓ Fundación Edmund Mach
- ✓ Viñedos Biodinámicos (producción de compost)
- ✓ Huertos de Cerezo (Cubiertas de Protección)
- ✓ Producción Hidropónica de Frutilla

ALTO ADIGE



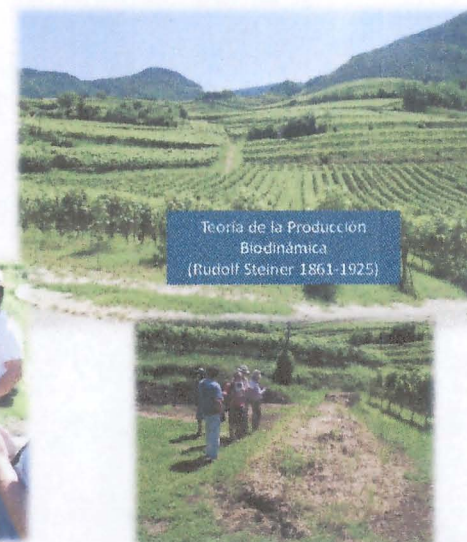
Visita Region del Trentino, San Michele All'adige, Trento



Visita Region del Trentino, San Michele All'adige, Trento

Nombre responsable: Enzo Mescalchin
Especies cultivadas: Viñedos
Superficie cultivada: 15 ha

Innovación:
Sistema Biodinámico de Producción
Viñedo experimental



Biopreparados Biodinámicos

Especies utilizadas en la formulación de los biopreparados para agregar a los abonos:

- ✓ Milenrama (*Achillea millefolium*) 502
- ✓ Manzanilla (*Matricaria chamomilla*) 503
- ✓ Ortiga (*Urtica dioica*) 504
- ✓ Roble (*Quercus pubescens*) 505
- ✓ Diente de león (*Taraxacum officinale*) 506
- ✓ Valeriana (*Valeriana officinalis*) 507



En base a Plantas medicinales

Biopreparados 502 al 506 son sólidos

Biopreparados 507 es líquido
(agua no clorada)

LOS PREPARADOS PARA PULVERIZAR SOBRE EL SUELO Y LAS PLANTAS

En cuanto a los dos preparados para pulverizar:

- ✓ **500:** Para rociar el suelo, en base a **estiércol de vaca** (sin paja).
- ✓ **501:** Para rociar las plantas, en base a cuarzo (sílice cristalizada, silicio). Es necesario reducir a polvo el cuarzo para que éste sea capaz de acoger y conservar, después de todas las manipulaciones, las fuerzas cósmicas tal como lo hacen las sustancias orgánicas.



Biopreparado de Maria Thun:

FLADEN (para descomposición de material vegetal sobre el suelo)



Preparación de boñiga en cuerno (Preparado 500)

- ✓ A principio de otoño se llenan los cuernos de vaca (que haya tenido varios partos) con estiércol sin paja, preferiblemente de vacas preñadas, de manera que no queden espacios de aire en su interior.
- ✓ Se entierran hasta la primavera en suelo de pradera o de forraje que tenga una buena capa de humus.
- ✓ Hay que evitar los suelos pantanosos, los suelos con raíces de árboles o arbustos y las cercanías de muros de caminos y de zanjas.
- ✓ El contenido se saca del cuerno y se almacena en un lugar seco, en un cajón rodeado de turba rubia. Los cuernos pueden volver a usarse (se guardan en la vaquería).

Preparación de Sílice en Cuerno (Preparado 501)

- ✓ El cuarzo es molido hasta dejarlo como harina fina.
- ✓ Se mezcla con agua de lluvia para hacer una lechada densa y se pone en el cuerno dejándolo escurrir varios días.
- ✓ Los cuernos se entierran durante el verano y se sacan a final de septiembre o principios de octubre.
- ✓ Se saca el contenido para almacenarlo en un bote de cristal en un lugar soleado y seco. Los cuernos de este preparado no conviene reutilizarlos.



Según Steiner, los preparados para rociar, de boñiga en cuerno y de cuarzo en cuerno, afectarán la dinámica del crecimiento de la planta en todo su ciclo. Ambos preparados se remueven enérgicamente en agua tibia de manera que con el movimiento se forme un fuerte remolino. Durante una hora se va cambiando alternativamente el sentido del giro.

SISTEMA
MANUAL



Los biopreparados deben ser dinamizados

SISTEMA
AUTOMATICO



La pila de Compost
Biodinámico
(10 a 15 ton/ha)



- ✓ Guano de vacuno o caballo
 - ✓ Hierba
- ✓ Paja o leña de poda
- ✓ Biopreparados (502 a 506)

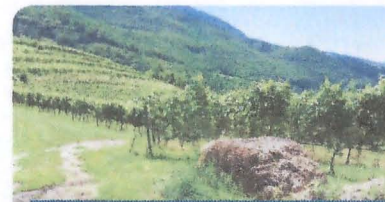
Aplicación del Biopreparado 501 (DE SILICE)

- ✓ Aplicar directamente sobre las hojas de las plantas, desde las 4 de la mañana hasta cuando el Sol está alto (hacia las 12 de la mañana).
- ✓ La cantidad a aplicar de preparado será de 4 g/ha y aplicando unos 40-50 litros de **agua dinamizada**.
- ✓ Las plantas se activan para recibir de una manera más armónica la luz necesaria para realizar todos sus procesos vitales, desde el crecimiento vegetativo hasta la floración y la fructificación.
- ✓ Este preparado ayuda a proteger a la planta frente al desarrollo de hongos.
- ✓ El único momento en el que **no se puede aplicar el preparado 501 es cuando las plantas están en floración ya que puede secar flores**.



- ✓ También se puede aplicar después de la cosecha
- ✓ Una aplicación cuando la fruta está cuajada hace que el producto adquiera más aromas de la tierra.
- ✓ Si aplicamos antes de cosecha, el fruto se hace más aromático y sabroso y ayuda a la conservación y cualidades para el transporte y almacenamiento.

Visita Region del Trentino, San Michele All'adige, Trento



- ✓ No se han evidenciado mermas en la producción ni en calidad de fruta
- ✓ La importancia de la calidad y sanidad del suelo en la producción Biodinámica (auto-nutrición)
- ✓ Análisis de Producción de Compost Biodinámico (Pila de Compost)
- ✓ No forzar a la planta a un ambiente no apto para su cultivo
- ✓ El sistema biodinámico produce plantas más "eficientes y resistentes"
- ✓ La importancia de la mano de obra y la asociatividad entre productores (sin problemas en Italia)
- ✓ Bajo costo de control fitosanitario



Visita Region del Trentino, San Michele All'adige, Trento



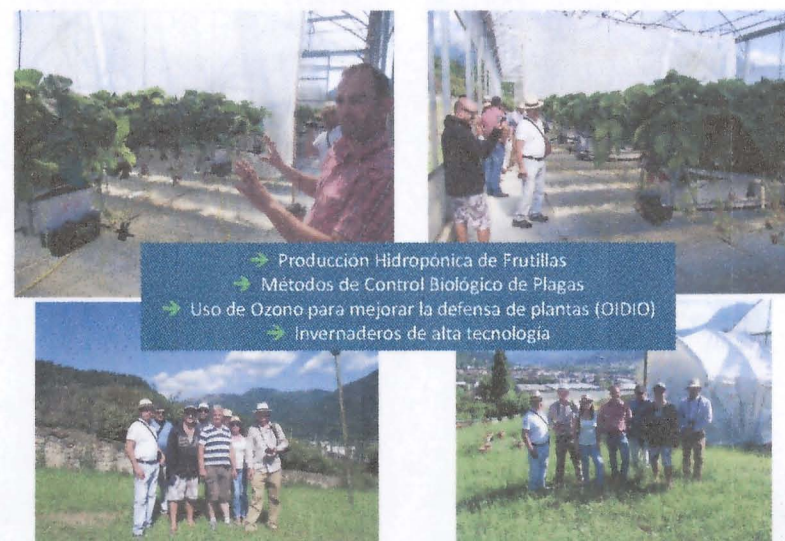
Visita Region del Trentino, San Michele All'adige, Trento



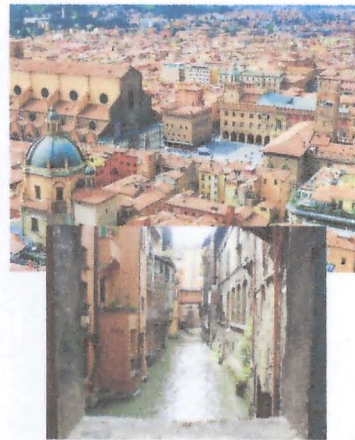
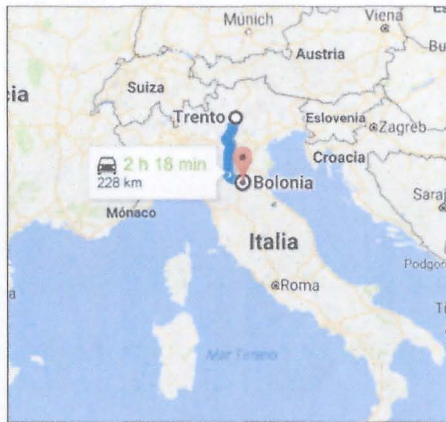
Visita Region del Trentino, San Michele All'adige, Trento



Visita Region del Trentino, San Michele All'adige, Trento



Visita Region de Emilia-Romagna, Bologna, Universidad de Bologna



Visita Region de Emilia-Romagna, Bologna, Universidad de Bologna



ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

Fundada en 1088



Profesor Adamo Doménico Rombolà (CONTACTO EN ITALIA, COORDINADOR EXTERNO)



Visita Region de Emilia-Romagna, Bologna, Universidad de Bologna (UNIBO)



Cátedra de Sistemas Agrícolas
Altamente Sustentables



Visita a Dependencias de La Escuela de
Ciencias Agrarias y Veterinarias

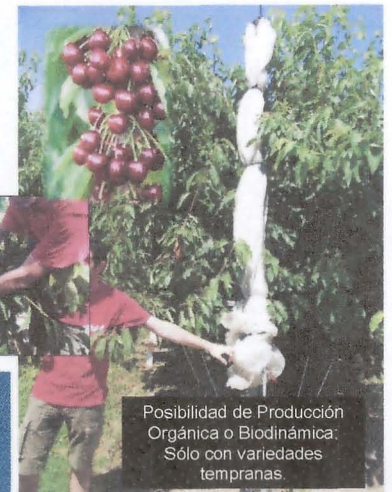


Centro Experimental Agrícola CADRIANO



Visita a Huertos Experimentales de Cerezos

- ✓ Presentación de variedades SERIE SWEET
- ✓ Poda de producción
- ✓ Uso de portainjertos y sistemas de conducción
- ✓ Uso de Cubiertas

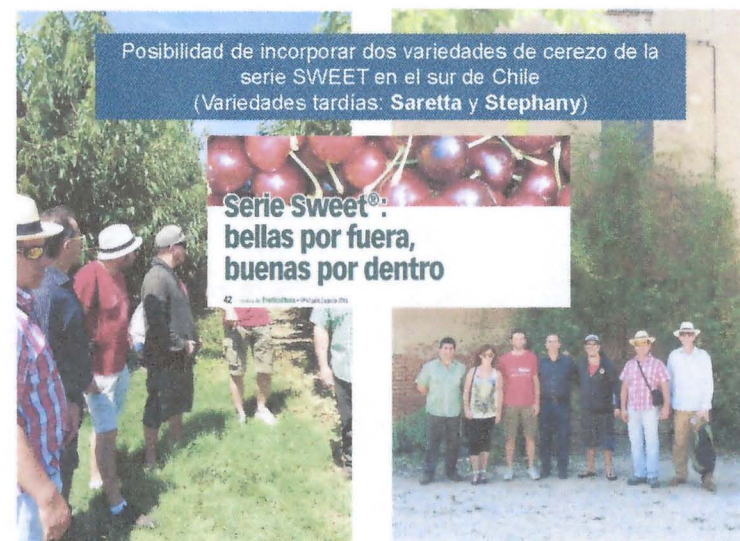


Posibilidad de Producción
Orgánica o Biodinámica:
Sólo con variedades
tempranas.

Visita Region de Emilia-Romagna, Bologna, Universidad de Bologna



Visita Region de Emilia-Romagna, Bologna, Universidad de Bologna



Visita Region de Emilia-Romagna, Provincia Bologna, Montevoglio (Colli Bolognese)



Asesoramiento en Agricultura Biodinámica y Ecológica KVARCON

Fincas, invernaderos e industrias agroalimentarias; Plan de Reconversión, Normativa

INICIO "COME VIDA BIO" - PRODUCTOS ECOLÓGICOS Y/O BIODINÁMICOS FRESCOS. AGRICULTURA BIODINÁMICA - HISTORIA
CONTACTO A ASESOR BIODINÁMICO EL ASESOR BIODINÁMICO GALERÍA DE IMÁGENES BIODINÁMICAS LOS PREPARADOS BIODINÁMICOS
NUESTROS SERVICIOS VENTA DE PREPARADOS BIODINÁMICOS



BUSCAR

DAIOS DE CONTACTO
José Carlos Hernández Barrio
30x10 00 34 977643749

ENTRADAS RECIENTES

- PREPARADOS BIODINÁMICOS DE OTORRHO
- Vino y Aceite de Oliva Virgen Extra - Biológico - Calidad Garantizada
- Tratamiento de Fitosanitarios de Fitosanitarios
- Productos de Agricultura Ecológica
- Experiencia en agricultura biodinámica. Soluciones de biofertilizantes para la salud de este mundo

VENTA DE PREPARADOS BIODINÁMICOS

Disponemos de todos los Preparados Biodinámicos que usted necesita para su aplicación en la finca, huerta, jardín...

- PREPARADO 500

- PREPARADO 501

- KIT DE PREPARADOS DEL COMPOST (500, 501, 502, 503, 504)

- MARTA THUN

También disponemos de las materias primas necesarias para la elaboración propia de éstos, como son:

- CTEROS DE VACA PARIDA

CACA DE VACA ECOLÓGICA para elaboración de preparados (500 y Marta

GALERÍA DE FOTOS BIODINÁMICAS

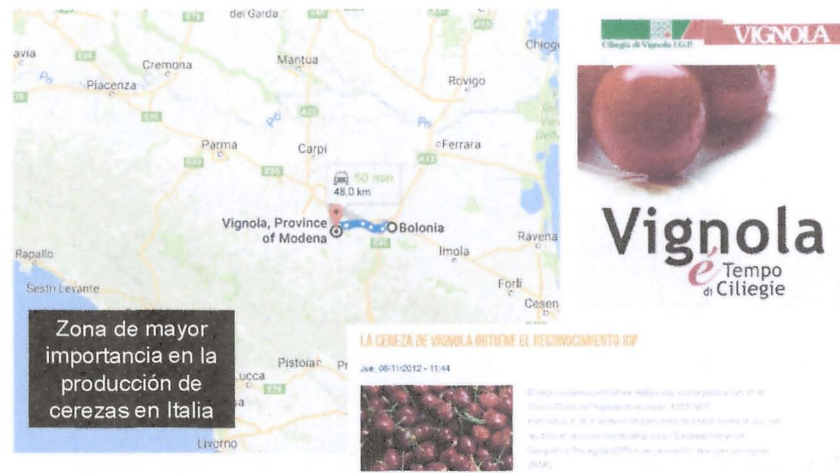


¡El primer día de la vida es el más importante! ¡El primer día de la vida es el más importante!

Visita Region de Emilia-Romagna, Provincia Bologna, Monteveglio (Colli Bolognese)



Visita Region de Emilia-Romagna, Provincia de Modena, Vignola



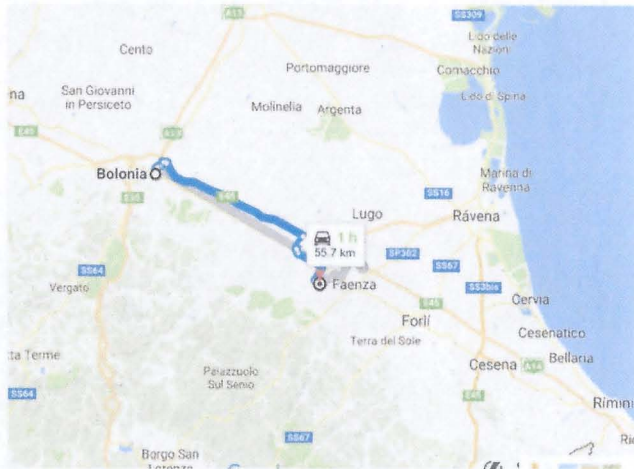
Visita Region de Emilia-Romagna, Provincia de Modena, Vignola



Visita Region de Emilia-Romagna, Provincia de Modena, Vignola



Visita Region de Emilia-Romagna, Provincia de Faenza, Polo di Tebano



Visita Region de Emilia-Romagna, Provincia de Faenza, Polo di Tebano



Visita Region de Emilia-Romagna, Provincia de Ravenna, Polo di Tebano



Nuestra Gira ha
sido difundida en
Italia

Visita Region de Emilia-Romagna, Provincia de Ravenna, Polo di Tebano



Nuestra Gira ha
sido difundida en
Italia

Visita Region de Emilia-Romagna, Bologna, Polo Tebano



Objetivos del Uso de Intercultivos en Sistemas de Producción Biodinámica

Uso de intercultivos o cultivos inter-hilera

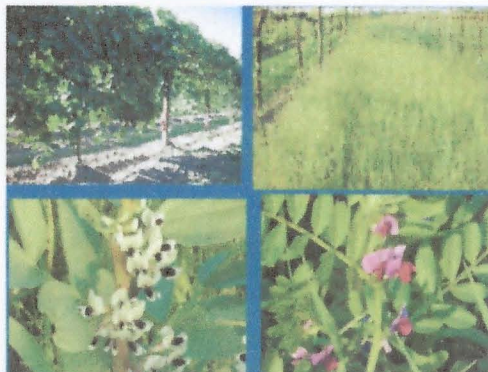
- ✓ Fertilidad del Suelo
- ✓ Manejo Hídrico
- ✓ Mejorar la Rentabilidad
- ✓ Control de plagas y enfermedades

Uso de cultivos sobre-hilera

- ✓ Fertilidad del Suelo
- ✓ Control del vigor
- ✓ Manejo hídrico
- ✓ Control de malezas

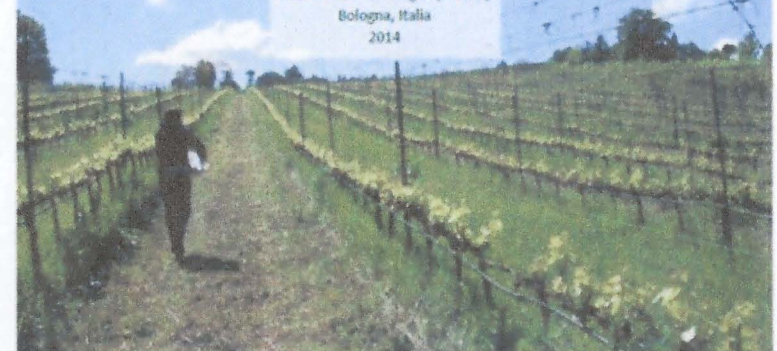
Especies utilizadas como intercultivos en viñedos orgánicos y biodinámicos

- ✓ Habas
- ✓ Arvejas
- ✓ Trébol
- ✓ Porotos
- ✓ Lupino
- ✓ Triticale
- ✓ Avena
- ✓ Cebada
- ✓ Mezclas

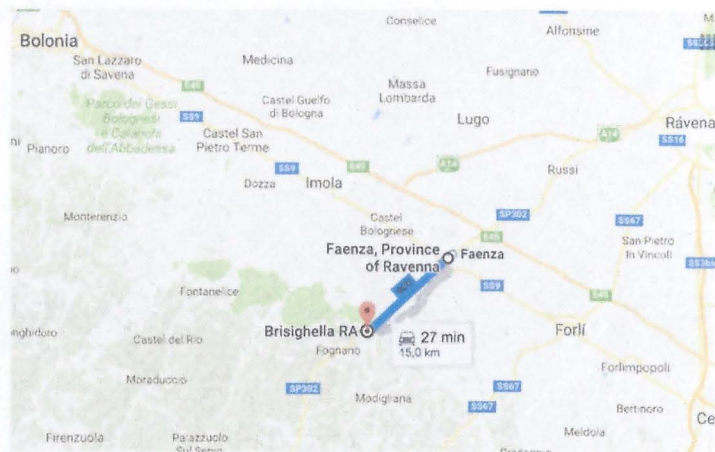


Experiencias en Viñedos Biodinámicos Región de Emilia-Romagna, Italia.

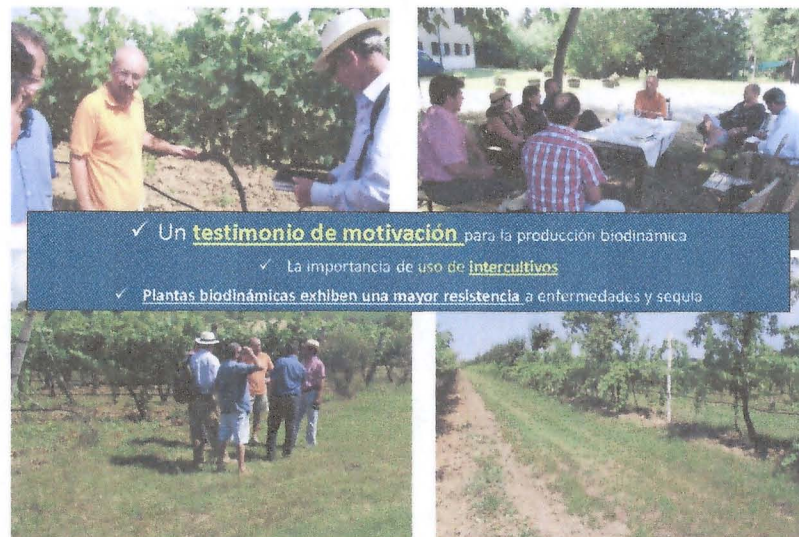
Polo Tebano
Universidad de Bologna (UNIBO)
Bologna, Italia
2014



Visita Region de Emilia-Romagna, Provincia de Ravena, Faenza-Brisighella



Visita Region de Emilia-Romagna, Provincia de Ravena, Faenza



✓ Un testimonio de motivación para la producción biodinámica

✓ La importancia de uso de intercultiivos

✓ Plantas biodinámicas exhiben una mayor resistencia a enfermedades y sequía

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Conclusiones



→ En Chile existe una deuda pendiente respecto a la producción orgánica y biodinámica de especies frutales. Es necesario avanzar. En Italia la producción biodinámica aún es incipiente.



→ Los predios visitados concuerdan en que no se detectan reducciones de la productividad en huertos biodinámicos, mientras la calidad de la fruta se mantiene o aumenta.



→ La producción biodinámica de berries y cerezo debe considerar como aspectos clave: calidad del suelo, sanidad de la planta, selección de variedades adaptadas y asociatividad.



→ El alto requerimiento de mano de obra y dificultad en la obtención de bio-preparados, constituyen dos de las principales limitantes para la producción biodinámica de frutas.

→ La destacable condición fitosanitaria de Chile permite considerar a la producción biodinámica como una oportunidad factible.

→ Plantas biodinámicas exhiben mayores niveles de resistencia a condiciones de estrés y una mayor eficiencia en el uso de recursos.

Conclusiones



→ La Producción Biodinámica Moderna permite obtener productos biodinámicos sin la necesidad de asociatividad a un relativo bajo costo.



→ El uso de cultivos sobre- y entre-hileras representa una interesante alternativa para mejorar la fertilidad de suelo, reducir los riesgos de problemas fitosanitarios, mejorar la eficiencia de uso del agua de riego e incrementar la rentabilidad del productor.



→ El éxito de las cooperativas y asociatividad entre productores parece responder a un aspecto cultural.

→ El ente de certificación de productos agrícolas biodinámicos es privado, lo cual dificulta el proceso y lo vuelve menos atractivo para el productor. Muchos producen biodinámico pero certifican como orgánicos.



→ En Europa existe una demanda no cubierta por berries y cerezos chilenos, la cual a la fecha no ha sido cubierta.

→ La inversión en nuevas formas de presentación, envases y calificación de berries y cerezo (denominación de origen, identificación geográfica, otros) es un desafío que se debe abordar.

→ EL ROL DE GOBIERNO ES FUNDAMENTAL EN EL APOYO DE ESTAS INICIATIVAS

Por un futuro más sano y sustentable



Proyecciones de Trabajo



→ Los dos productores de arándano que participaron en el Gira están interesados y mejor capacitados para implementar el sistema de producción biodinámica en sus huertos.



→ El productor de cerezos que participó en la Gira, ha establecido contacto directo con dueños de empresas productoras de cubiertas y está interesado en implementar prácticas biodinámicas en sus huertos, así como en ampliar su rubro a la producción de vides.



→ En un futuro próximo se trabajará en la formulación de un "Proyecto de Innovación" en colaboración (CAPACITEC + UFRO + PRODUCTORES) para la validación del Modelo Biodinámico de Producción de Berries para mercados de exportación, el cual será presentado a fondos concursales de CORFO y FIA.

→ Los nexos internacionales en el rubro se han consolidado y enriquecido tanto para la coordinadora, como para la empresa y los productores.]

