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Improving Milk Supply, Competitiveness and Livelihoods in Smallholder Dairy Chains in Indonesia

Review of Extension Methodologies

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Executive Summary

The Australian Centre for International Agricultural Research (ACIAR) project "Improving milk supply, competitiveness and livelihoods in smallholder dairy chains in Indonesia" aims to contribute to increasing milk supply (quantity and quality) by 25% for at least 3,000 dairy producers in the geographic locations of West Java and North Sumatra by 2020.

This review of existing technical material and successful extension methods both in Indonesia and internationally was commissioned to help inform project design and pilot delivery across two activities, covering four topic areas;

- Activity 3.2. Develop and deliver milk hygiene training for cooperative staff and farmers linked at the milk collection centres (MCC) in West Java.
- Activity 3.3. Pilot and evaluate technical training programs with extension staff and dairy service providers in West Java and North Sumatra. These three technical areas are ; Feeding systems and herd nutrition focussing on rations and silage making, Rearing young stock and reproduction management of milking herds, and Farm business management

The approach taken in the review was to explore and analyse a range information sources culminating in identification of best-bet extension methodologies for the project. The review commenced with analysis of extension methodologies to establish relevant frameworks, theory and principles, then explore technical focus, audience characteristics, value chain and delivery support, to enable a customised extension approach.

Analysis of the evolution of extension globally and in Indonesia, suggests that extension has been shaped by four defining elements; (i) The centrality of technology, (ii) The level of government investment/direction, (iii) Levels of participation by end users, and (iv) Engagement by non-government players. Throughout this journey to the present day, three extension paradigms emerged each with a different mix of these characteristics, namely Transfer of technology, Participatory extension, and Agricultural innovation systems.

In the transfer of technology (ToT) paradigm, farmers are seen as recipients of technologies generated at research stations first established during the colonial eras and disseminated via extension. This approach was best known in Indonesia as the "oil drop" diffusion approach. Around the world, including in Indonesia, the diffusion methodology was replaced by approaches which packaged agricultural recommendations into programs such as Training and Visit (T&V), which focussed on increasing rice yield to address food shortages in Indonesia. Whilst generally successful for increasing yields, T&V lacked flexibility to deal with more complex and diverse situations, and was replaced globally with participatory approaches such as Farmer Field Schools (FFS). During the early 1990s FFS was used to introduce integrated pest management (IPM) in Indonesia, following significant problems associated with pesticide use in rice crops. In 1999, Indonesia entered the new era in national policy with the implementation of regional autonomy and Law No 16 2006 which aimed at making the extension system more democratic, pluralistic, and participatory for smallholder farmers. This new era of pluralism is described globally as Agricultural innovation systems.

Regardless of the underlying theory or the various changes within agriculture, seven key models of delivery have been present, both in Indonesia and internationally;

1. Information access – focused on communication of basic principles via multiple means (newsletters, websites, field days)
2. Programmed learning – Education and training approaches typified by a mix of classroom and field based activities (eg: Train and Visit)

3. Facilitation and empowerment model – Based on building relationships and trust and user defined problem solving (discussion groups, focus farms, Farmer Field Schools)
4. Mentor/consultant – based on 1:1 visits and planning approaches. Built upon technical expertise of the consultant (farming systems approaches, whole farm assessment)
5. Technology development – Uses farm based trials as a mechanism to ground truth technology and apply findings to the farm context (farming systems research, variety trials)
6. Regulation – Applies a regulatory framework via various legislative means to drive behaviour change (eg: Nutrient management in Europe, NZ)
7. Market based instruments – Uses incentives to drive application of best practice (ie: Milk quality payments).

In the current pluralistic and information-rich extension space, we now find that we have an array of methods to choose from with the challenge being to match the method with the particular farm problem. Extension design has now moved from "best practice methods" of standardized models to "best fit" where location- specific, situationally-relevant models are used that are best suited to the context. In applying a 'best-fit" approach, authors of the review refer to a process-based design approach they call the Liminal Framework which encourages program developers to explore 4 key elements;

1. The nature of the problem/opportunity and characteristics of the topic area
2. Defining practice gaps within the target audience and associated characteristics
3. Analysis of service providers operating in that area, along with skills, gaps and technical resources
4. Designing 'best bet' extension approaches and deliverables to address the challenge, taking into account budget constraints and benefits.

Whilst the review authors recommend this process be worked through in detail for each topic area, a preliminary scan has been conducted for each topic area and associated case studies provide within the report.

With regards to problem context and characteristics of the topic areas; Milk hygiene and mastitis management stands out as an area where both participation and adoption should be high as it is not a complex problem area and has a clear benefit for farmers if price signals reward better milk quality. Whist cow nutrition is more complex, requiring a theoretical understanding to inform decisions, needs and benefits in terms of production are clear hence demand should be high and adoption at least moderate. Silage management is more straightforward technically, but may not suit all farmers. AS such participation could be low but adoption moderate. Reproduction management in contrast to milk quality and feeding, has less immediate or obvious benefits and seems less likely to be in demand or adopted. Taken together, there appears to be larger improvements in milk quantity and quantity, and higher likelihood of success, in areas of milk hygiene and feeding compared to reproduction and farm business management.

With regards to delivery approaches relevant to topic areas; Market based instruments have a central role to play in milk quality, and being a management of low complexity, standardised procedural knowledge can be shared through Information access and packaged in programmed learning methods. The case study on Kenyan smallholder dairy farms has shown this to be the case. Regarding nutrition, it would seem that a combination of programmed learning and one-to-one consultation is an appropriate methodology for skills training and decision support based on design principles, as used in the DIFS Live Dairy Feed Project. Silage extension lends itself to demonstrations, widely used in cropping extension. Regarding fertility management there are excellent resources available in this area however the key issue is buy-in and motivation of farmers, hence an issue-by-issue approach may be warranted, with the objective of showing short term improvements and benefits. Farm business management has obvious differences to physical farm management options and is less tangible. There would seem to be scope

for basic financial literacy at the household scale, with the linking of such work to cow feeding and milk quality being essential. Comparative analysis across the topic areas in the project suggests it will be important to scope, schedule, and co-ordinate activities across topic areas to create synergy and minimise duplication of effort.

A clear challenge for the project is to ensure that both Government and KUD extension staff are competent to deliver the planned activities. The starting point for training is often technical knowledge, however this review identified three additional dimensions of skill development which may be targeted during training, namely; leading and managing extension projects; extension design and evaluation, and; extension delivery and engagement. Identifying and developing capability in these areas will ensure the necessary mix of skills for sustained delivery. The review also found the need to plan for post training support and mentoring, particularly where group programmed learning and facilitation is involved.

Finally, the review explored Information and Communication Technologies as an aid to extension delivery, and concluded it can be used in a range of forms to support different extension functions with the best use likely to involve integration across a range of options combined with traditional approaches. The use of phone text and calls was seen as a starting point.

Based on considerations explored within this review, some guiding principles emerge;

- The identification of the problem context in terms of farm practice is a clear starting point for each of the interventions.
- Identification of service providers and support personal with skills and/ or a stake in the area of focus provide the basis for the delivery support team.
- Adoption characteristics, and content of the information resources help to inform the skills required to deliver, and associated training and extension approaches.

These three elements need to be integrated into the design phase to plan how each method in the extension strategy complements the other, including train-the- trainer activities, creating the platform for scheduling, delivery, and review/evaluation of interventions.

Introduction

The overall goal of this project is to contribute to increasing milk supply (quantity and quality) by 25% by 2020 for at least 3,000 dairy producers in the geographic locations of West Java and North Sumatra. The project has 3 objectives:

- Objective 1: Identify and recommend strategies and policies to support development of sustainable, profitable and smallholder-inclusive dairy supply chains in North Sumatra and West Java.
- Objective 2: Identify barriers to adoption of profitable management practices and farm business models and develop strategies to inform development of extension programs in West Java and North Sumatra.
- Objective 3: Develop, pilot and evaluate innovative extension approaches in West Java (and North Sumatra) that improve on-farm profitability of smallholder farmers

As part of project objective 3, project activity 3.1.2 is to "Review existing technical material and successful extension methods both in Indonesia and internationally", which in-turn will help inform project design and pilot delivery (activities 3.2 and 3.3). This review of extension methodologies is the focus of the current report.

Review approach

The approach taken is this review will be to explore and analyse a range information sources culminating in identification of best-bet extension methodologies for the project. The review will commence with analysis of extension methodologies to establish relevant frameworks, theory and principles, then explore technical focus, audience characteristics, value chain and delivery support, to enable a customised extension approach, as per the following steps.

1. Explore global trends in agricultural development, and Indonesia-specific factors
2. Review extension approaches used in Indonesia and internationally
3. Analyse extension approaches, methods, frameworks, theory and principles
4. Review relevant case studies of extension approaches in action
5. Identify best-bet extension methodologies for the project based on technical focus, audience characteristics, value chain support, and proposed project delivery

The evolution of extension globally

Since the second half of the nineteenth century, where the work of research stations was "extended" into the farmer community, the evolution of extension has been shaped by four defining characteristics; (i) The centrality of technology, (ii) Level of government investment/direction, (iii) Levels of participation by end users, and (iv) Engagement by non-government players. Throughout this journey to the present day, three extension paradigms emerged each with a different mix of these characteristics, namely Transfer of technology, Participatory extension, and Agricultural innovation systems. The table below summarises how each of these core methodologies differs in relation to these defining characteristics and in the following section we explore each of these paradigms in more detail.

	Centrality of technology	Level of Government leadership/ direction	Level of participation by end users	Engagement by non- Gov't players
Transfer of technology	H	H	L	L
Participatory extension	M	M	H	M
Ag innovation systems	Varied	L	H	H

Transfer of technology

In the transfer of technology (ToT) paradigm, farmers are seen as recipients of technologies generated at research stations and disseminated to them via extension agents (Ponniah et al, 2008). ToT is described as a top-down approach, characterised by high centrality of technology and level of Government leadership/ direction, and low level of participation by end users and other extension providers.

Early examples of this approach are the outreach activities from Oxford and Cambridge universities in England, and from Land Grant universities in the USA, during the last part of the nineteenth century (Boon, 2009; Swanson 2010), and ToT remained the dominant extension approach for the most of the twentieth century across the world. During what has been described as the colonial era, experimental stations were established in many developing countries, with focus on producing export crops like rubber, tea, cotton and sugar.

After independence of these developing countries the focus changed to meet the needs of smaller farmers to increase production with support from foreign donors (Anderson, 2006; Uddin,2008). World Bank, as a key foreign donor, introduced a technology transfer approach called Training and Visit (T&V) from the mid 1970's to the late 1990's across more than 50 developing countries (Musa et al, 2013). T&V aimed to address weaknesses in developing countries' extension services and to increase food production by improving yields of major crops grown by small-scale subsistence farmers (Boon, 2009).

Eventually after two decades of T&V, the Work Bank ceased funding country-by-country once national food security was achieved (Swanson, 2008). Assuming that the new system had been mainstreamed, funding returned to the lower levels of the past which could not sustain the training and visit system

(Anderson and Fedora, 2004) as it cost 25–40 percent more than the systems they replaced (Anderson, Feder and Ganguly, 2006). According to a review by the World Bank's Operations Evaluation Department of research and extension investments in the 1980s and 1990s, only three out of five T&V extension projects in Africa were "satisfactory in achieving their stated objectives (Davis, 2008). T&V was seen more successful in promoting specific packages, with associated yield increases, in relatively homogenous farming systems (Davis, 2008), however the mechanistic nature of the program was not flexible enough to meet the needs of diverse farming systems (Ponniah, 2009). Issues around inadequate knowledge transfer from contact farmers to the community (Musa, Aboki, & Audu, 2013) also contributed to its decline.

Like the generic ToT activities promoting technologies from research stations, T&V used a top-down approach assuming diffusion of the technology from more progressive farmers to less progressive. The diffusion process assumed by ToT activities was first described in Rogers' now famous "Diffusion of Innovations" theory (see Rogers,1983), where he depicted the process of innovation being influenced by characteristics of the adopter, communication in a social system, and characteristics of the innovation, all affecting rate of adoption over time.

Whilst Rogers' theory managed to describe headline elements involved in technology adoption, subsequent critique of the theory highlighted (i) the pro-innovation bias assuming adoption of that particular technology to be a good thing and relegating non adopters as laggards (Kelly, 2012) , and (ii) absence of consideration for the technology fit with producers goals (Kaine, 2008). Such overemphasis on technology and under-emphasis on farmer context was a key driver for the advent participatory extension, discussed in the next section.

Participatory extension

Following experience with the "one- size-fits-all" ToT approaches such as T&V it became clear in the 1980's and 1990s that the ToT paradigm had limitations within the complex, diverse and risk-prone agriculture in developing countries of Asia and Africa (Ponniah, 2008), with a more inclusive approach being needed to stimulate further development (Swanson 2010). Participatory approaches offered potential for complex agricultural and environmental problems to be understood and resolved by farmers (Kaine, 2008; Kelly,2012). The new paradigm of participatory extension placed emphasis on people rather than technology, and distributed power to participants (Ponniah, 2008). Hence, participatory extension is characterised by reduced (moderate) centrality of technology and Government leadership/ direction, with a high level of participation by end users and non-government players.

In an environment of participatory extension, farmers are recognised as active seekers of advice, information and opportunities to learn how to improve their production systems and livelihoods, and to set their own priorities (Garforth, 2010). Instead of starting with the knowledge, problems, analysis and priorities of scientists, it starts with the knowledge, problems, analysis and priorities of farmers and farm families (Black, 2000). In this new paradigm, farmers analyse, choose, experiment and evaluate, while outsiders convene, catalyse, advise, search, supply and provide support and consultancy (Ponniah, 2008).

Participatory extension is based on social learning principles, whereby farmers as part of community groups initiate, organize, and take action to achieve common interests and goals (Boon, 2009. Understanding of technical attributes of technology is only part of the puzzle and participants are more

aware of the broader system within which technology is applied and used. While economic factors are important they are not necessarily the dominant motivational drivers (Garforth, 2010).

Participatory rural appraisal (Chambers, 1994) and participatory action research (Lewin, 1946; Reason & Bradbury, 2008; Argyris 2002) are examples of participatory approaches. Participatory rural appraisal has more of a needs identification/ planning focus, whereas participatory action research is a cyclical process of issue identification, planning and action (Ponniah, 2008).

Farmer Field Schools (FFS) are perhaps the best known example of participatory extension in developing countries, originally associated with promoting Integrated Pest Management in rice during the 1980s in FOA-supported projects in Indonesia and the Philippines, and spread other regions (Rivera, 2001). FFS's were been mostly funded by FAO and International Fund for Agricultural Development (IFAD) (Waddington & White, 2014). FFS is a participatory training method that involves a "learning by doing" approach whereby 20–25 farmers, through weekly field observations and analysis, supported by a facilitator (an extension agent), test and adapt farming practices to their local conditions. Participants in the FFS are selected with community involvement and are expected to contribute to the community after the FFS (Glendinning, Babu & Aswnso-Okyere,2010).

Meta-analysis of FFS impacts has shown significant impact in achieving pesticide reduction and other beneficial practices, increases in production, increased knowledge and self-esteem among farmers, and empowerment (Waddington & White, 2014). However Glendinning, Babu & Aswnso-Okyere (2010), and Davis (2008) note the difficulty to scale up the benefits received by farmers who participate in the FFS to farmers who do not directly participate their analysis. These views are endorsed in the analysis by Waddington & White (2014), which also indicates that the impacts were sometimes negative on neighbouring farms.

AKIS Agricultural Innovation systems

The decline of centralised extension delivery by Governments, and a move away from centralised information packaging and towards localised knowledge generation in participatory approaches towards the end of the 20th century, lead to greater diversity in providing agricultural extension and information sources in what has been described as "pluralism" of agricultural extension (Garforth, 2010; World Bank, 2012). In 1988, Röling introduced the idea of Agricultural Knowledge and Information Systems (AKIS) in response to the recognition of the involvement of multiple groups, organisations and individuals in rural development (Boon, 2009; see Röling 2004), and defined AKIS as:

> *"a set of agricultural organizations and/or persons, and the links and interactions between them, engaged in such processes as the generation, transformation, transmission, storage, retrieval, integration, diffusion and utilization of knowledge and information, with the purpose of working synergistically to support decision-making, problem solving and innovation in a given country's agriculture" (Ponniah,2008).*

AKIS integrates farmers, researchers, extension and education in one system, in what is known as the knowledge triangle and focuses on how the three activities generate new knowledge and information for farmers (FAO, 2000; Ponniah, 2008).

Although farmers require information for the whole food and agriculture value chain, the public extension system largely concentrates on on-farm activities (Glendenning, Babu & Asenso-Okyere, 2012). Throughout the developing world evolving demands and new roles for advisory services in the

wider innovation system will require investments in the capacity of individual extension workers and organizations for value chain approaches, in market- oriented extension, in group and organizational development, in agribusiness, and in mechanisms to share information (World bank, 2012). Traditional depictions of the value chain illustrate only product flows however inclusion of information flows, (ie: Kawambwa, Hendriksen, Zandonda, & Wanga, 2014) is more informative to extension in this new era of extension and information pluralism (Figure 1).

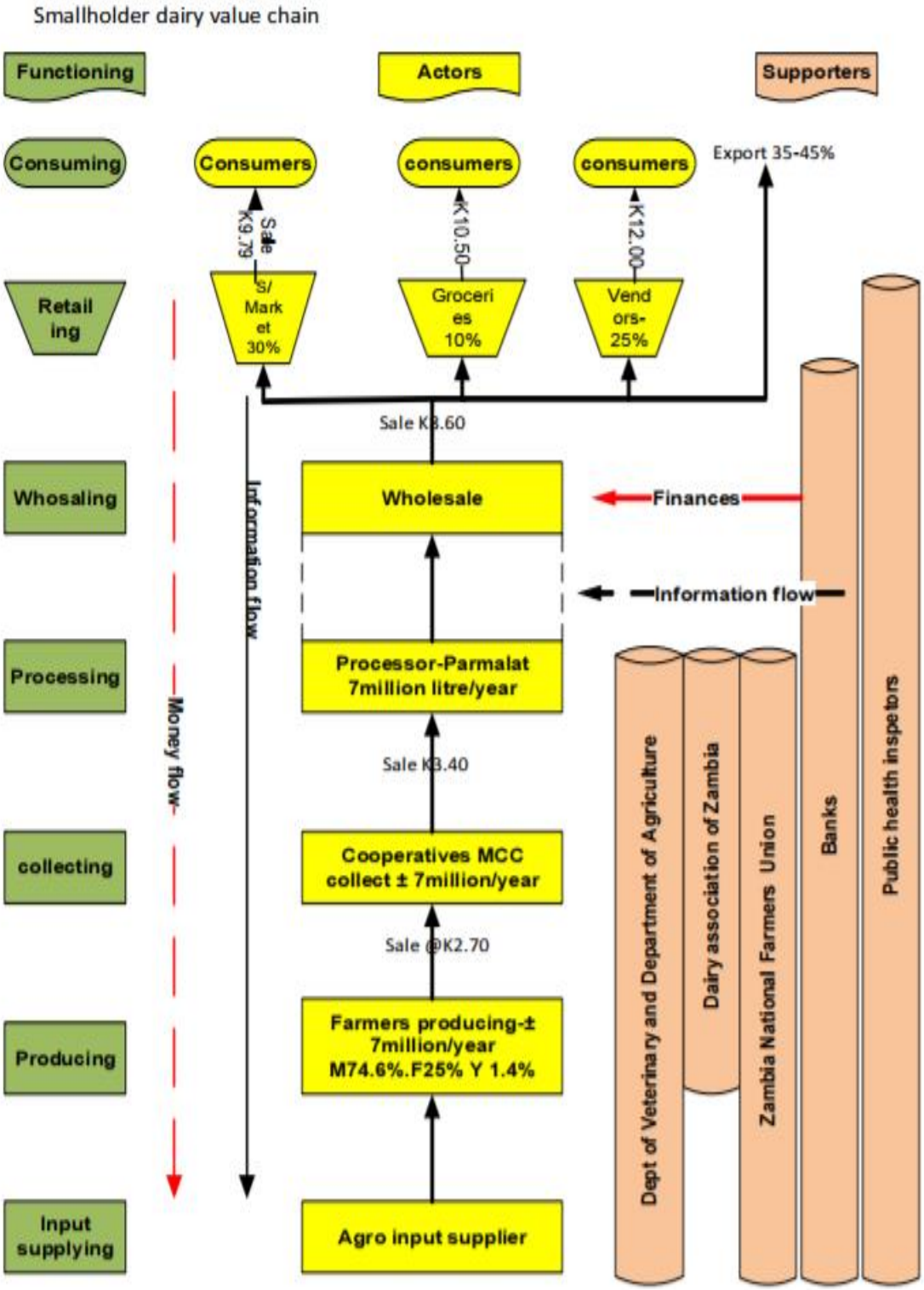


Figure 1. Smallholder dairy chain showing information both product and flows (Kawambwa, Hendriksen, Zandonda, & Wanga, 2014)

Extension has now entered an era of increased diversity across the world, with different mix of methods and extension services as highlighted by Davis (2008) in the case of the sub-Saharan Africa. FAO (2000) caution that AKIS systems are still emerging and yet to reach their potential, but highlight potential benefits of a broader range of service providers and stakeholders with different strengths to improve mutual learning and robustness of AKIS into the future. Likewise, Klerkx , Koutsouris & Labarthe (2013) note that we still lack knowledge on the ability of AKIS in different contexts to produce relevant knowledge for farmers, to facilitate appropriate interaction among AKIS actors, and to support sustainable development of agriculture. Klerkx , Koutsouris & Labarthe (2013) also make the point that diverse AKIS and advisory systems in various countries will reorient discussion on extension from the idea of 'best practice' towards the idea of 'best fit', a theme picked up again later in this review.

Indonesian context for agriculture and extension

Agriculture and specific dairy industry context

Like other countries, Indonesia has been part of the global trends in agricultural development, experiencing changes in supply chains, climate, demographics, and use of technology such as ICT, along with changes in production, productivity, profit and prices paid. As such, Indonesian dairy farmers face a number of risks associated with climate, markets and the impact of technological and social change. These risks have the potential to shift the power in the supply chain further post farm gate and minimise their capacity to use their resources for their benefit.

The Indonesian agricultural sector has a crucial role for the economy because of its significant contribution to economic growth, foreign exchange earnings, and in achieving food security, and also has strategic roles in reducing poverty, providing employment, and improving farmers' welfare (FAO, 2013). Agriculture share of GDP has been stable at around 15 percent from the 1990s then declining slightly from 2002, while employment share has remained stable around 45 percent of GDP over recent years (Winoto & Siregar, 2008). Hence agriculture is a moderate producer of the countries' wealth but a high employer, implying a low level of labour productivity, profitability, and prices or wages received. This situation also reflects the fact that more than 60 percent of poor people in Indonesia live in the rural area where they mostly rely on agriculture sector for livelihood (FAO, 2013).

Dairy is an important agricultural industry sub sector with over 100,000 Indonesian dairy farmers (Morey, 2011), and with 98% of the 525K dairy cows located in Java and the other 2% in Sumatra, Sulawesi and NTB (MacMud, 2016). The majority of cows in Indonesia are owned by individual farmers with an average of three to four cows each, and where dairying is only a part time business for most of these farmers (Morey, 2011). Most dairy smallholder farmers supply milk to a village-level co-operative called a KUD (Koperasi Unit Desa), which collects, quality-checks, then markets the raw milk to privately-owned manufacturers (Daud, Putro, & Basri, 2015). KUDs also supply farmers with advice and services on management and are the key link between farmer and milk processors. KUDs in turn are members of the Indonesian Association of Dairy Cooperatives (GKSI) which oversees industry development including policies regarding accessing funding for infrastructure and cattle (Morey, 2011).

In addition to improved income for a large number of dairy smallholders' rural areas, the dairy industry provides employment for workers along the value chain from input suppliers, to collection centres, manufacturing employees, and transport, all contributors to GDP and increased rural prosperity.

Indonesian milk supplies only 30% cent of domestic needs and processors still depend on imports for 70% of their supply (Vanzetti, Setyoko and Oktaviani, 2013). With increasing demand driven by Indonesia's growing middle class predicted to reach 68.2% of the total population in 2020 from 56.5% in 2010 (Wright & Darmawan, 2016), it is possible that the rate of demand may again outstrip supply growth as it did between 2002-2007 when demand grew 14% and production increased by only 2% (Astuti, Adiarto, & Agus, 2016). Considering Indonesian per capita milk consumption is currently much lower than other ASEAN countries at 14.3 litres compared to Philippines 22.1 litres, Thailand 33.7 litres, and Malaysia 50.9 litres (Wright & Darmawan, 2016), strong demand growth is likely, especially when coupled with population increase.

Recognising the likelihood of strong domestic growth in demand for milk, and the national benefits of a larger and more productive dairy sector, the Government of Indonesia (GoI) has set an ambitious target to achieve 50% milk self-sufficiency by 2020, up from the present 30% (Soedjana, 2012). With current dairy cow milk production averaging only 10 litres per cow per day, and the best farms achieving more than 25 litres per cow per day (Morey, 2011), production increases offer a pathway to this self-sufficiency goal through components of dairy farming such as breeding, feeds and feeding, husbandry management, diseases control, as well as marketing (Soedjana, 2012), plus more land and stock numbers, and value chain efficiencies. Guntoro, Rochijan, Widyobroto, Indratiningsih, Umami, Nurtini & Pertiwiningrum (2015), in their research on dairy value chains in Java, found that constraints differentially impacted small scale farmers, and recommended that specific services, technologies, and policies that take account of their specific needs and interests are required.

Further information about the situation, characteristics and goals of small scale farmers in West Java and North Sumatra will be obtained from a survey in project Activity 2.1. This activity will involve the collection and analysis of detailed farm-household level economic and financial data aiming to identify and understand of farm-level profit drivers, management and technology options in relation to cost of production, contribution of dairy (milk and cattle sales) to household income, enterprise profitability and viability. It will also help to understand the role of women in farm households and their potential to contribute to improved farm productivity, and to understand the relationship between variables measured, such as adoption/ non adoption, perceived risk, different barriers to adoption, and relevant household characteristics such as low access to information, capital constraints, participation in an existing dairy program, farmer group or segment. Finally, it will help understand current practices and potential to improve in relation Best Management Practices (BMPs) identified by a panel of dairy scientists, socio-economists, extension officers, dairy processors, input suppliers, government representatives and farmer representatives.

Extension context

In Indonesia, the history of agricultural extension was closely aligned with the history of agricultural development as it was throughout most developing countries in Africa and Asia. Agricultural development was initiated during the Dutch colonial era, commencing with demonstration of about agricultural crops in the Bogor botanical garden in the early 1800's, setting up agricultural research centres, and establishing an Office of Agricultural Extension in the early 1900's which operated until the Japanese colonial era in 1942-1945 (Hariadi, 2012; Lubis, 2012)

During the Japanese occupation, and throughout its early independent years and until the beginning of the 1960s, Indonesia faced serious food shortages which led the Government to embark upon a prolonged campaign to achieve self-sufficiency in rice production (Resosudarmo & Yamazaki, 2011). The

first extension efforts to increase rice production occurred in the Soekarno era with a mass extension method, known as the oil drop oil slick method, where the oil drop represented farming practices developed in research centres spreading by diffusion into the farming community (Hariadi, 2012).

In 1963 the oil drop approach was followed by a more persuasive model, called BIMAS (Bimbingan Masal or Mass Guidance), supported by demonstrations, and packages of agricultural recommendations, loans for seed and fertilisers, and supervision, delivered by extension agents and hundreds of university students from the Agricultural University of Indonesia, now Bogor Agricultural University (Cahyono, 2014; Resosudarmo & Yamazaki, 2011). Farmers involved in the BIMS program reportedly achieved harvest yields around 50 percent greater than non BIMAS farmers (Resosudarmo & Yamazaki, 2011), and rice productivity doubled in the demonstration areas (Herianto et al, 2010). However, as the BIMAS program expanded, criticism emerged about the guidelines being too strict for farmers to adhere to, problems with provision and mark up of fertilisers and pesticides, and difficulties repaying loans (Resosudarmo & Yamazaki, 2011).

When Soeharto came to power in 1966, BIMAS continued but improvements were made, along with significant strengthening of agricultural extension through establishment of research, extension, and training departments (Herianto et al, 2010). Under this regime with extension was delivered mainly through the Training and Visit (T&V) program under the umbrella of the BIMAS Program, with sponsorship from the World Bank from the mid-1960s until the end of the 1980s (Resosudarmo & Yamazaki, 2011). Rice production increased substantially during BIMAS, and undoubtedly contributed to ensuring secure food supplies (Resosudarmo & Yamazaki, 2011) whereby Indonesia achieved self-sufficiency in rice by 1984 (Chaidirsyah 2013).

Despite the gains made through BIMAS technology practices, progress came at a cost with crop losses due to pesticide resistance and pesticide-related illness in farmers leading to abolishment of the pesticide subsidy in 1989 and cessation of T&V in the early 1990s (Resosudarmo & Yamazaki, 2011). In the wake of pesticide issues, Integrated pest management (IPM) was deemed to be the preferred management option, but with the high cost of the intensive and formulaic T&V approach and the relative complexity of IPM a new extension approach of Farmer Field Schools (FFS) was initiated. Rather than top-down rote compliance of pesticides use, the more complex management approach of IMP was learnt and practiced using experiential learning, sharing information about pests and their predators amongst neighbouring farmers (Herianto et al, 2010). Delivery efficiencies were achieved by farmer training of fellow farmers to supplement training by extension officers, and by 1992 approximately 200,000 farmers were trained in IPM practice, with approximately ten percent chosen to receive further training to become trainers (Resosudarmo & Yamazaki, 2011). Even with efforts to expand delivery, up-scaling whilst maintaining quality of farmer-to-farmer delivery was difficult with only 5% of farmers participating by the time the program financial crisis hit in the late 1990's and FFS programs were terminated (Resosudarmo & Yamazaki, 2011).

In 1999, Indonesia entered the new era in national policy with the implementation of decentralized or regional autonomy, shifting the paradigm from centralized to decentralized approaches, and from a production to an agribusiness approach (Chairdirsyah, 2013). Initially, decentralisation led to winding down of extension services until Indonesia launched the Revitalization of Agricultural Extension strategy in 2005 and the declaration of Law No 16 2006, System of Agricultural, Fishery, and Forestry Extension in 2006 (Lubis, 2012) which aimed at making the extension system more democratic and participatory, especially for smallholder farmers (Agunga & Putra, 2015).

The new law No 16 2006 encouraged development of a more pluralistic extension service with Government, private and NGO extension institutions, and acknowledges the role of farmers supporting farmers (Lubis, 2012). Under Law No 16 2006 local government are obliged to organize agricultural extension institutions at provincial and district levels, with funding shared responsibility between the central and local governments and with farmers and private funding, and organization arranged jointly between the extension and farmers (Chaidirsyah 2013a presentation). Every sub-district typically has a Rural Extension Centre as the base for field extension workers covering several villages, with internet access at each centre supporting the cyber extension initiative since 2007, and since 2009 the government has had a strong focus on developing farmer groups under the association of farmer groups (Haraidi, 2012)

From best-practice to best-fit extension

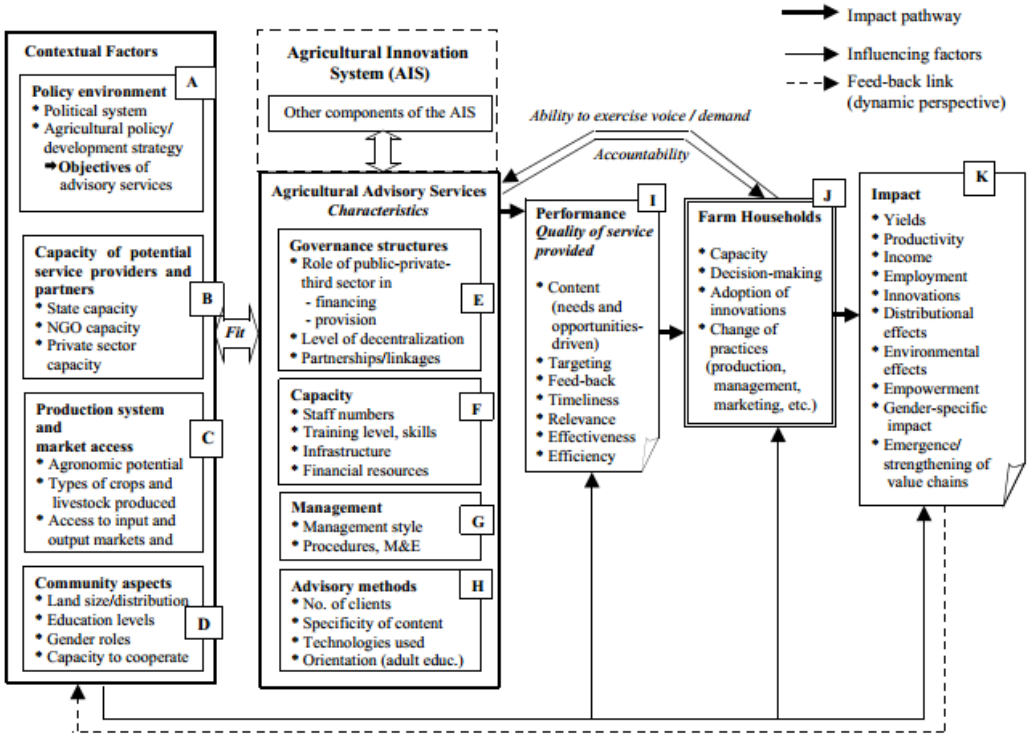
Towards best fit extension approaches

Whilst recognising the strengths of well-regarded extension methodologies such as FFS, Qamar (2005) raised concerns that push by sponsors for their universal use across all technical subjects and geographical regions, was neither logical nor technically sound. In this respect Davis (2009) and others (eg: Faure, Davis, Ragasa, Franzel, & Babu, S. C. , 2016; Klerkx , Koutsouris & Labarthe,2013; Swanson, 2010,& World, Bank, 2012), have called call for a move from "best practice" of standardized models to "best fit" where location- specific, situationally-relevant models are used that are best suited to a particular context. Modern pluralistic extension services with a mix of public, private and community players provide a foundation for such approaches, drawing on the unique knowledge, skills and networks of each partner.

Ponniah et al (2008) posit that selecting a pre-designed extension approach is less important than its ingredients, and argue the need to isolate the ingredient of success and find ways to replicate or transfer their characteristics to improve and customise approaches Noting that limited attention had been given to the factors that influence which types of extension approaches are most suitable in a given context, Birner et al (2009) developed a framework for designing and analysing pluralistic agricultural extension services (FFDPAES) worldwide, to inform the transition move from best-practice to best-fit extension. Their framework proposed that extension methodologies need to be adapted to;

A. policy objectives of the extension service, and available resources
B. (and F) capacity and capability of potential service providers and supporting infrastructure
C. type and complexity of the agricultural system, and potential to improve
D. characteristics of the communities to be served , including size and distribution of farms, social networks, and personal characteristics of farmers
E. (and G) governance structures in relation to management and role of players, and partnerships/ linkages
H. extension methods including technical content, delivery mode and orientation
I. performance and accountability metrics for success such as quality of delivery, reach, perceived relevance
J. changes sought by farm households such as attitudes, capacity, decision-making, and practice changes
K. anticipated impact of changes such as from innovation, empowerment, productivity, environment, value-chains

Faure et al (2016) reviewed and tested the Birner et al (2009) framework for designing and analysing pluralistic agricultural extension services, and concluded it is one of the few holistic design frameworks available which explains how different components of an extension system interact and operate, their performance, and their impact. In addition to consideration of the components they emphasised the importance of interaction between components.



Project logic is another design framework, and interaction between components of an extension program is a strength of this approach. Project logic is described as "a systematic and visual way to present and share your understanding of the relationships among the resources you have to operate your program, the activities you plan, and the changes or results you hope to achieve (Kellogg Foundation 2004)". Theory-of-action is another name for program logic (Dart, 2006). Bennett's Hierarchy is a project logic approach initially developed describe and evaluate agricultural extension programs, then later used as a program design framework (Rockwell & Bennett, 2004). Bennett's hierarchy contains remarkably similar design elements to the Birmer et al (2009) framework, but has the added advantage of systematically working through a sequence of steps starting with desired change, to participation, which inform selection of extension activities, and resources required, as described below;

(i). The first step in Bennett's hierarch is to identify desired impact in terms of social, economic, and environmental conditions (SEEC) that need improving
(ii). The second step is about identification of practices needed to achieve the desired impact
(iii). Step three in the hierarchy requires assessment of changes sought by farm households in relation to knowledge, attitudes, skills, and aspirations
(iv). The fourth step in the hierarchy relates to participant reactions to the extension delivery
(v). The fifth step is about identifying participants and reach targets
(vi). The sixth step relates to design and delivery of extension activities
(vii). The seventh and final step in Bennett's hierarchy is identifying the resources required to deliver the extension program or service

Clearly, Bennett's hierarchy is less comprehensive design tool than Birner et al, nevertheless contains many of the required design considerations with added bonus of evaluating at each steps to provide a comprehensive account of progress.

A third design framework, called the Liminal Framework developed, has been created by the authors of this review and used to design and review a number of programs. The liminal framework combines elements of the Birner et al FFDPAES and Bennett's hierarchy. Like Bennett's Hierarchy, the liminal framework is a stepwise process, however has the added sophistication of components similar to those in the Birner et al FFDPAES. Comparison is shown in Table 1 below.

The liminal framework commences with analysis of problem and opportunity, and practice gap analysis leading to benefits of change for end users. Defining the project scope and focus gives consideration to target audience and a scan of gaps in the current services. Having identified the change targets, audience, and service gaps the next step is to define the project delivery methods and activities, and identify capability and collaboration required to deliver. The next step is to clarify and describe indicators and metrics of success, and establish budget from which value and benefit-cost can be estimated for the investor. With appropriate participation of farmers, advisors and technical expertise, the above process has the greatest chance of realizing the objectives of the project. The point is that this is not about backing winners, but developing an extension methodology that best fits the context.

Table 1. Comparison of RCG Liminal Framework, with corresponding steps in Bennett's hierarchy, and components in Birner et al Framework for designing and analysing pluralistic agricultural extension services

Element in RCG Liminal Framework	Corresponding step in Bennett's hierarchy	Component in Birner et al FFDPAES
• Problem & Opportunity identification	• Level 1 SEE changes	• Component "A" policy objectives of the extension service, and "K" the anticipated impact of changes
• Practice Gap Analysis within the context	• Level 2 Practice change • Level 3 KASA change	• Component "C" potential to improve • Component "J" changes in decision-making, and practice changes
• Benefits of change – for end users	----------	----------

• Defining the project Scope & Focus: Target audience
  • Target audience
  • Service scan & gaps
	• Level 5 Participation	• Reach aspect of component "I" and component "D" characteristics of the communities to be served

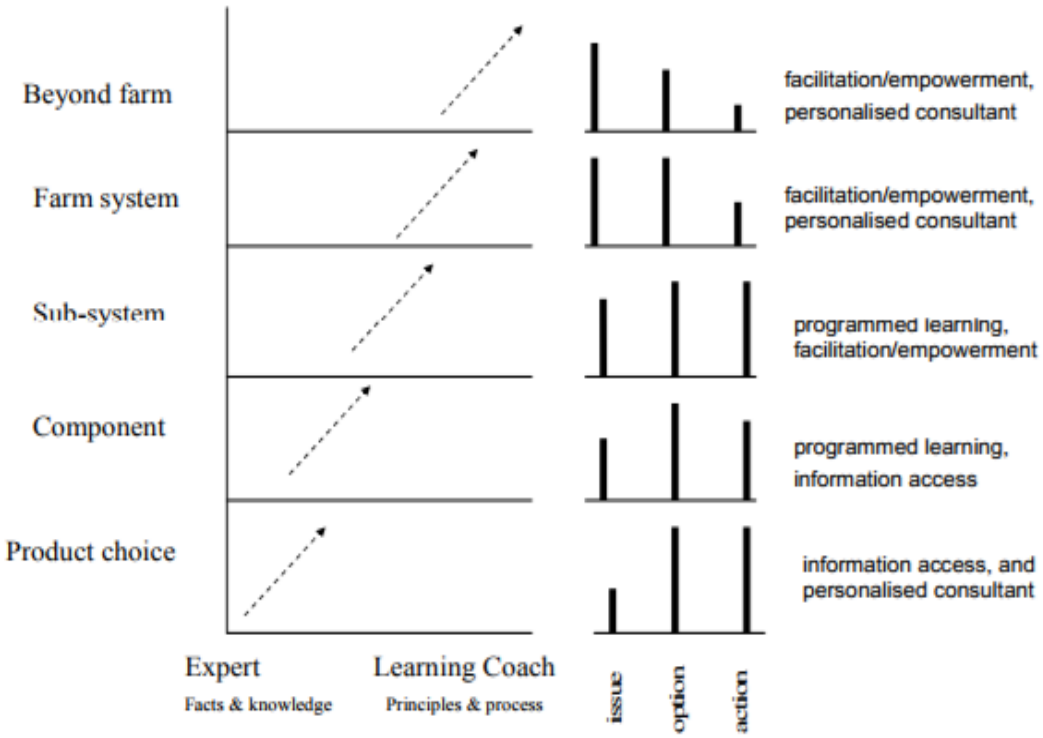
• Identifying the capability & collaboration required to deliver	----------	• Capability aspect of components "F" capability of service providers • Components "E" & "G" governance structures, roles and linkages
• Defining the project strategy & deliverables – methods and actions	• Level 6 Extension activities	• Component "H" extension methods including technical content, delivery mode and orientation
• Describing indicators of success	• Level 4 Participant reactions	• Component "I" relating to performance and accountability metrics for success such as quality of delivery, reach, perceived relevance
• Budget, Value & Benefit: Cost – for the investor	• Level 7 Resources	• Capacity aspect of components "B" & "F" capability of potential service providers and supporting infrastructure

Methods

Regardless of the underlying theory or the various changes within agriculture, seven key models of delivery have been present, both in Indonesia and internationally (adapted from Coutts, 2006)

1. Information access – focused on communication of basic principles via multiple means (newsletters, websites, field days)
2. Programmed learning – Education and training approaches typified by a mix of classroom and field based activities (eg: Train and Visit)
3. Facilitation and empowerment model – Based on building relationships and trust and user defined problem solving (discussion groups, focus farms, Farmer Field Schools)
4. Mentor/consultant – based on 1:1 visits and planning approaches. Built upon technical expertise of the consultant (farming systems approaches, whole farm assessment)
5. Technology development – Uses farm based trials as a mechanism to ground truth technology and apply findings to the farm context (farming systems research, variety trials)
6. Regulation – Applies a regulatory framework via various legislative means to drive behaviour change (Nutrient management in Europe, NZ)
7. Market based instruments – Uses incentives to drive application of best practice (Milk quality payments).

When selecting methods, one key consideration is which method is best suited to a particular farm management decision. For example Resosudarmo and Yamazaki (2011), in their comparative review of T&V versus FFS, suggested that for regions where the level of development is still very low a T&V program instructing farmers what to do is probably more appropriate than an FFS, whereas for regions where agriculture is relatively developed an effective FFS program seems more appropriate. A paper by Drysdale, Markham, Mark Paine, Michael, & Crawford (2010) reached similar conclusions, arguing that participatory approaches emphasise identification of issues versus simply following recommended actions, and such approaches are best suited to complex or high level decisions as shown in the diagram below. In this paper they categorised farm management complexity in terms of levels of decision making from level one product choice decisions, to level five beyond-farm decision. Based on this schema, they recommended that highly participatory and interactive methods such as Facilitation and empowerment model and mentor/consultant be used in complex decision making such as farm system level, compared to programmed learning and Information access at lower component-level decisions,



Cases & considerations

Extension analysis approach for topic areas

In this section of the review, each topic area will be analysed from the perspective of;

- project context, adoption characteristics, and technical resources available, then;
- examined through a case study or studies, and finally;
- discussed regarding considerations for project extension

Adoption characteristic of the topic area will consider;

- complexity in terms of levels of decision making (Drysdale, Markham, Mark Paine, Michael & Crawford, 2010) from level one product choice decisions, component decisions, farming sub-system decisions, farm system decisions, to level five beyond-farm decision
- characteristics of the innovation (Rogers, 1983) including relative advantage, compatibility with the current farming system, complexity, and trialability

Extension design considerations will then be examined through the case studies and the considerations discussion afterwards, based on the process elements the Liminal framework discussed earlier;

- Technical focus → considering 1. Problem & Opportunity identification, 2. Practice Gap Analysis within the context, 3. Benefits of change
- Target Audience → considering 4.Audience characteristics and opportunity for improvement
- Extension providers → considering 5. Service scan& gaps 6. Identifying the capability & collaboration required to deliver

Milk quality training for cooperative staff and farmers

Project context re this technical area

Milk quality has been identified as a focus area for the project with Activity 3.2 aiming to develop and deliver milk hygiene training for cooperative staff and farmers linked at the milk collection centres (MCC) in West Java. The outcome would be for farmers to produce raw milk of higher quality hence provide greater opportunities to supply high value dairy markets. The primary objective of this initiative as part of Activity 3.2 would be to improve the bacterial quality of milk ex-farm with the vision of accessing supply chains with higher profit share for farmers. Sub-outcomes would to improve the knowledge of basic milking hygiene of small holder farms, to demonstrate the close association between milking hygiene and bacterial contamination of raw milk, both on farm and post farm gate which would improve milk quality on farm, and assist in the development of on farm mastitis control programs. According to Morey (2011) poor raw milk quality is a major problem for the use of locally produced milk by the dairy industry with only 12% of milk production meeting the minimum standard.

Adoption characteristics of this technical area

Raw milk quality is measured by Total Plate Count (TPC) which refers to the total number of bacteria per millilitre that can grow at a specific temperature in a sample of milk taken prior to pasteurisation, and is used to monitor the effectiveness of milking equipment sanitation and hygiene during milking, and the efficiency of milk cooling. The term BMCC (also known as a somatic cell count), refers to the number of white blood cells per millilitre of raw milk, and is an indication of infection within the udder such as mastitis. Failure to exclude mastic milk from harvesting, and unhygienic storage at farm level and along the chain are exacerbate by tropical environment encourages rapid growth of these bacteria, the prolonged time delays in cooling the milk to 4ºC, reduce its quality even further ((Moran, 2009).

Complexity in terms of levels of decision is low, being a small component of the farm system (Level 2 as per Drysdale, Markham, Mark Paine, Michael & Crawford, 2010). Regarding adoption characteristics of this technical are (Rogers, 1983) improved mastitis management has including clear relative advantage if price signals reward better milk quality, compatibility with the current farming system is high, complexity low, but trialability is only moderate as it is really an all or nothing approach.

Technical resources available for this technical area

Milk quality is an issue in dairy industries throughout the world, with mastitis-related quality and general hygiene important contributors. Countdown 2020 is the national udder health program for the Australian dairy industry and focuses on mastitis-related quality issues, however general hygiene issues also apply.

Case study: Countdown 2020

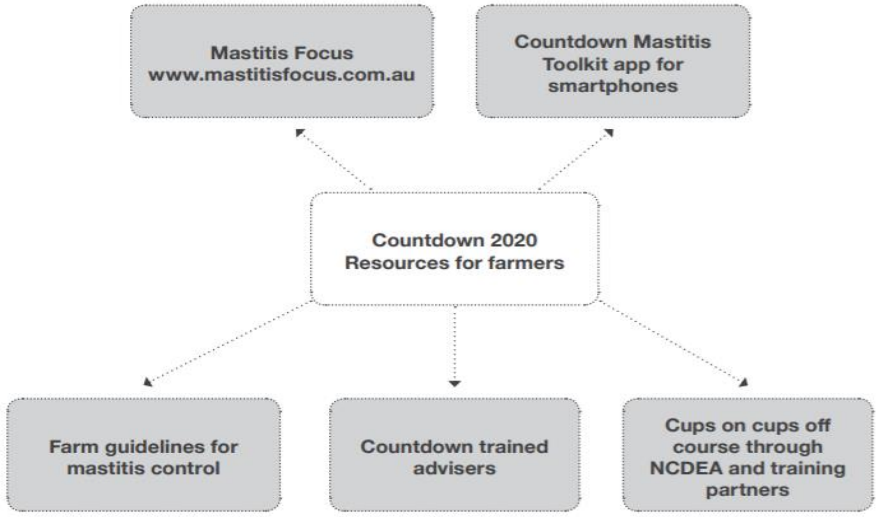
http://www.dairyaustralia.com.au/~/media/Documents/Animal%20management/Mastitis/Countdown%20resources%20and%20tools/Countdown%202020%20-%20June_2016.pdf

Focus/ Rationale: Countdown 2020 has a clearly identified problem that poor milk quality diminishes the dairy industry's ability to compete in desired markets, and recognise an opportunity exists for Australian dairy farmers to make significant gains. The initiative has a goal to have at least 70% of Australian dairy farms supplying milk with an annual average Bulk Milk Cell Count (BMCC) of less than 250,000 cells/mL by 2017, and monitor progress against this goal in an annual survey. For example in 2000, 63% of farms reached this standard, whilst 67% reached the standard in 2013. Benefits have been estimated using an economic model of Australian farms, showing increased income from lowering the annual average Bulk Milk Cell Count (BMCC) and shows there are gains to be made right down to very low Bulk Milk Cell Counts. For example, decreasing BMCC from 350,000 cells/mL to 250,000cells/mL is worth $155 per cow to a farmer. In addition to economic benefits, as BMCC goes down there decreased new infection rate and BMCC becomes easier to manage.

Target audience: the Target audience is Australian dairy farmers with high BMCC.

Service providers: Manufactures already have in place a method to encourage milk quality standards and provide advice through field officers. Most dairy factories in Australia pay farmers different rates for milk of different BMCC quality (often as part of milk quality payment schemes which also include a number of other factors such as Total Plate Count). Milk supplied with a BMCC below a specified threshold (eg 250,000 cells/mL) qualifies for a premium in addition to the standard price. Milk with a BMCC above a specified threshold may lead to a penalty below the standard price. In some states there is a ceiling BMCC above which the factory will not collect the milk. Veterinarians have always had a role with animal health advice. Similarly, Government extension officers have provided advice, and the National Centre for Dairy Education Australia (NCDEA) is another service provider option.

Project strategy/ Method: Countdown has developed tools/ methods for delivery using three avenues to the target audience; (i) Countdown trained (veterinarian) advisers delivering information via Mentor/consultant method; (ii) Cups on cups off course through NCDEA and training partners through Programmed learning; (iii) A web site, farm guidelines, and a smartphone app available which are all Information Access methods. A fourth method operating , but not part of Countdown, is the Market based instrument of quality effect on milk pricing put in place by dairy manufacturers.



Case Study: Intervention with Kenyan smallholder dairy farms

This case study is constructed from the paper by VanLeeuwen et al (2011) Management, productivity and livelihood effects on Kenyan smallholder dairy farms from interventions addressing animal health and nutrition and milk quality.

Focus/ Rationale: Milk from smallholder dairy farms in Kenya is used for family consumption, with the remainder being sold for income, an essential element to improving their quality of life and offering a potential pathway out of poverty. However, many smallholder dairy farmers have major limitations to producing ample quantities of high-quality milk for consumption and sale.

Target audience: The objectives of this research project were to describe the management and productivity of a sample of 30 smallholder dairy farmers belonging to the Wakulima Self-Help Group Dairy (WSHGD) at the beginning of the project and to document observed changes in the 3rd year of the intervention program.

Service providers: Farmers Helping Farmers (FHF), a non-governmental organization of volunteers with agricultural backgrounds provided funding, in partnership with the faculty and students from the Atlantic Veterinary College (AVC) at the University of Prince Edward Island (UPEI) in Charlottetown. Hiring and training of a full-time Kenyan veterinarian, and a milk quality technician, and two Kenyan agronomist, who provided their technical expertise and acted as translators. Visiting Canadian staff with expertise in a variety of areas.

Project strategy/ Method: All active members of WSHDG were provided with a post-milking teat dip, sponsored by a pharmaceutical company at no cost, and provided with an instruction on how to use the teat dip as part of a mastitis prevention program. Milk tests were initiated to ascertain if rejected milk was a function of subclinical or mild clinical mastitis and/or associated with the hygiene of the cattle and/or milking equipment, and this was accompanied by veterinary and/ or technician visits to farms with mastitic milk to treat cows to educate farmers to change management practices related to poor milk hygiene or handling, or both. A handout was produced that explained the reasons for rejected milk and the control measures to prevent rejected milk. Seminars and farm visits were conducted by Canadians on milk quality and hygiene control. Over the three years the amount of

rejected milk was reduced, and the reported mastitis incidence rate fell from 0.55 to 0.20 cases/cow-year, and local staff gained credibility and expertise in milk hygiene.

Funding was used to establish new service complex with a new milk can cleaning and drying bay, feed, laboratory, veterinary office, accounting office, and management office and a new credit co-operative was started. Having all of these services in one location made access easier for farmer members to benefit from the services.

Support for forages and feeding was provided via new demonstration plot of different grasses constructed by Kenyan agronomists, who provided individual advice to farmers wishing to instigate inclusion of these forages on their farms, with assistance from the agronomist if necessary. Storage of good-quality forage in silage bags was demonstrated by the agronomists and trialled by the farmers. Seminars and farm visits were conducted by Canadians on topics feed production, and cattle nutrition. Stock numbers increased from 1.5 to 2.9 cows, and 0.9 to 2.6 young stock per farm, and qualitative evidence suggested fatter cows with higher milk yields, and higher incomes.

Considerations for the ACIAR project

Project documentation states that in the earlier years of the project, a focus on the design and delivery of milking hygiene and quality training is likely to lead to the largest impact in the shortest amount of time, and that the processor Cimory have very clear and effective pricing signals through to the farmer, incentivising their suppliers to produce milk at higher quality. Target audience is therefore initially likely to be smallholder dairy farmers who supply milk to Cimory. Milk Collection Centre (MCC) staff, and suppliers of dairy equipment and chemicals who may provide advice to farmers, are likely to be targeted for training.

The case study on Kenyan smallholder dairy farms by VanLeeuwen has shown that a combination of methods involving pricing signals through market based instruments combined feedback and one-to-one mentor/consultant support, and boarder awareness through seminars – ie information access, underpinned by hygiene-enhancing infrastructure, can yield significant improvements in milk quality on smallholder farms. The Countdown 2020 also relied quality testing and pricing signals, enhanced by broader education and one mentor/consultant support. The broader education component was in the form of guidelines and courses, but included web-based and smart-phone ICT information and tools. Both cases used a train-the-trainer approach to ensure that qualified service providers were available.

The SNV/ Nestle case study, in the next report section on “Training program for extension staff and service providers across technical areas, (i) Feeding systems and herd nutrition”, addresses milk quality in addition for forage and feeding, and uses a comprehensive set of interventions to enhance milk quality market built on based mechanisms, including audits, and competitions, and assistance with milk cooling infrastructure, whilst no specific training is apparent.

Clearly Market based instruments have a central role to play, and being a management of low complexity, then standardised procedural knowledge can be shared through Information access and packaged in programmed learning methods. It would also seem pertinent to run a campaign or feedback to ensure that farmers buy-in to the need for improved quality, and benefits, so that market mechanisms are not just seen as punitive. Training of service providers or support staff along the value chain would also be an essential element, and ensuring that milk cooling arrangements are adequate is another important intervention area.

Pilot Programs and training for extension staff and service providers across technical areas

Generic approach/es being considered by the project

While yet to be negotiated, it is anticipated that two or three KUDs in West Java (near Bogor or Bandung) with 7000+ smallholders will be primary partners in the pilot phase (Activity 3.3) of practice change methodologies. To achieve the overall project goal, this would mean that approximately 25% of smallholders would be required to successfully adopt these practices (3000 smallholders). A milk processor will be identified as a collaborator to provide a communication platform outside of the primary target farm base.

Use of participatory rural appraisal (PRA) will help to build capacity of extension staff in participatory approaches and build relationships with farmer groups likely to be involved in technical pilots (Activity 3.3) and delivery of practice change programs. Activity 3.3 in the project is to pilot and evaluate technical training programs with extension staff and dairy service providers in West Java and North Sumatra. The approach for this activity will be to pilot and test an integrated service provider (public and private) training in year 3. Practice change programs will be designed, tested and delivered in collaboration with key Indonesian partners (such as ICARD, KUDs and Dinas Peternakan) to build capacity of dairy service providers, extension staff and smallholder farmers in West Java and North Sumatra.

An activity to be piloted will include a focus farm approach, which will aim to identify commercially orientated farmers with business growth and profitability aspirations to host training and workshops for extension staff, service providers and farmers. Two key focus farms will be developed in West Java and North Sumatra. Participants in training exercises will revisit these farms at two three month intervals post workshop delivery not only to receive additional training, but also to advise and monitor these farms through their change process

Effective capacity building activities and training program are likely to use multiple components which will align with the characteristics and needs of the participants which will be identified in Activity 2.1. The mix of methods will range from broader awareness raising activities to more detailed training workshops. The range of extension activities and capacity building opportunities may include, but not be limited to:

- short courses or workshops, preferably given at the village level;
- facilitated sessions between farmer group members and technical officers;
- information provided by successful farmers;
- use of media including audio-visual aids, radio, films, slideshows or public meetings, etc.;
- on-farm demonstrations or focus farms organised jointly with local counterparts on improved farm management and livestock practices;
- written extension materials;
- simple newsletters prepared together with the beneficiaries, village unit cooperatives (KUDs) or extension staff;
- initial and successive field action workshops;
- farmer exchange visits, within Java or between West Java and North Sumatra;
- conducting evaluation exercise with key collaborators.

(i) Feeding systems and herd nutrition

Project context re this technical area

Project documentation suggests that various aspects of both feed management and herd nutrition, especially in ration formulation and silage management, could significantly improve the profitability of smallholders. The objectives of such activities would be to improve the knowledge of basic dairy cow nutrition in small holder dairy farmers; to provide mechanisms for dairy farmers and advisers to predict milk responses from different feeding strategies; to predict the effect on income for dairy farmers of manipulating feeding regimes; to demonstrate the production benefits from better feeding lactating dairy cows and understand the target body conditions at different stages of lactation, gestation and dry period to optimise cow performance; to demonstrate the variability of individual components of formulations and the effect this has on the quality of dairy concentrates used to feed dairy cows and to make the association between forage quality and milking performance.

Adoption characteristics of this technical area

Ration formulation and silage management have quite different adoption characteristics, which may require different extension approaches, and possibly involve different audiences and delivery teams, that will need be taken into account.

Complexity in terms of levels of decision is reasonably low, with both silage and ration formulation being components of the farm system (Level 2 as per Drysdale, Markham, Mark Paine, Michael & Crawford, 2010), however the input-output calculations involved with feeding add complexity. Similarly integrating these elements into the farm system is more complex level 3 sub-system decisions.

Regarding adoption characteristics of silage management, the long lead time and costs of silage until usage will likely dilute the perception of relative advantage, however, the shorter window of dry weather required with silage making is likely to be immediately seen as an advantage. Compatibility with the current farming system may be low if fodder conservation is not already practiced, and while complexity of the decision is low the risk and of failure such as inadequate sealing of silage during storage high. Trialability is high, with the option to trial on a limited basis, and the silage-making process is easily observed and demonstrated.

Adoption characteristics of ration formulation differ from silage in several ways. For example, hence relative advantage would be more readily apparent than with silage as benefits of improved rations are immediately seen during lactation. Although trialability is high like silage, with the ability to test milk responses a various times with different feeds, the results are not as easily observed as nutritional inputs and milk output responses need to be measures to be appreciated. The need for measurement to understand benefits, limits the ability to share results through visual demonstration. Once a feed cost-milk price overlay is added, potential adopters need to both understand the numbers and trial for themselves, necessitating skills training rather than adoption of practice in that area. Compatibility with the current farming system relates to the need for storage and feeding infrastructure if supplements have not been used before.

Resources available for this technical area

Comprehensive resources are widely available on making of silage such as Moran's (1996) book "Forage conservation: Making quality silage and hay in Australia", and the "Successful Silage" TopFodder manual (Kaiser et al,2004). Resources targeted at tropical dairy farming but not smallholder production area the

book “Successful Dairy Production in the Sub-Tropics” by Callow (2013), and Japan Livestock Technology Association (2005) “Guide for silage making and utilisation in the tropics”. Recognising that such resources designed for large and modern farms are not totally relevant to smallholder farms in the humid tropics, Moran (2005) dedicated a chapter to this topic in his book on “Tropical Dairyfarming”. The chapter is practical and relevant to smallholder farms in Indonesia, with sections on why make silage, storage, steps to making quality silage, and silage from by-products and maize. Research undertaken at ICARD Ciawi provides locally relevant research resources, searchable through Indonesian Agricultural Research abstracts.

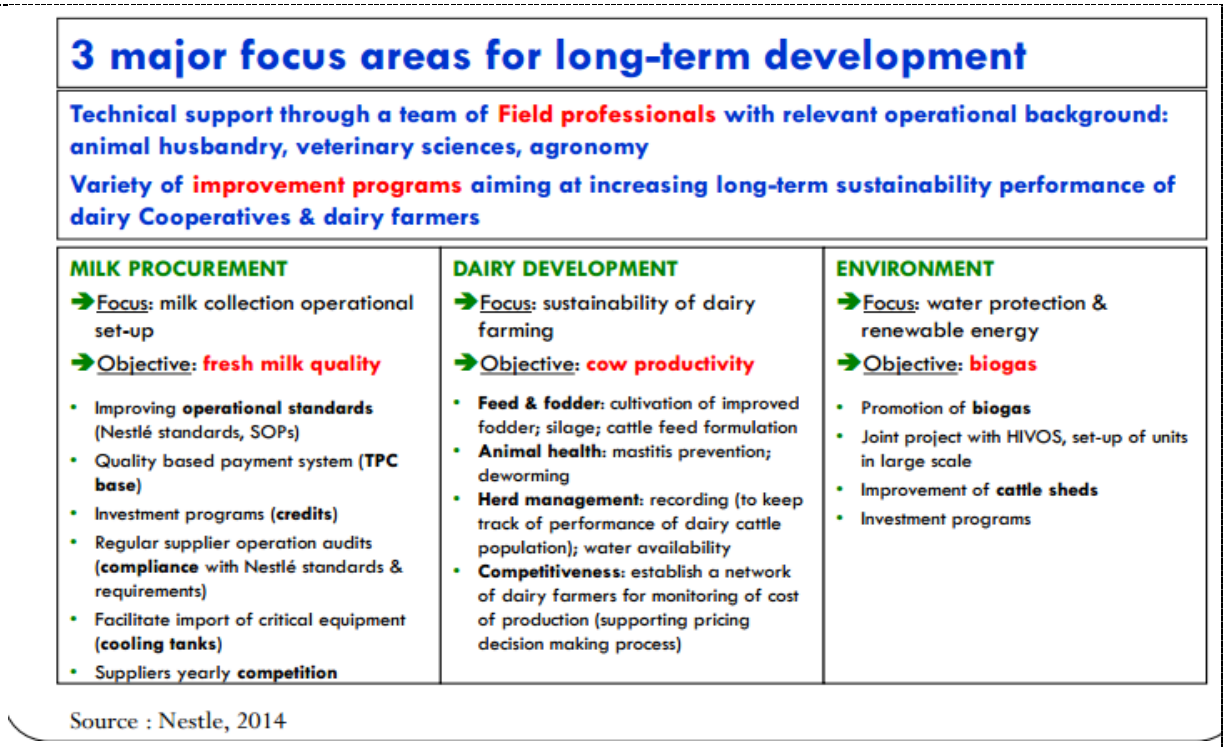
Information on herd nutrition has probably been more extensively published that silage, as the principles apply across contexts. “Tropical Dairyfarming” by Moran (2005) for example has chapters on What is in feeds, How the Rumen works, Nutrient requirements of dairy cows, How feed requirements change during lactation, Supplements for milking cows, Milk responses to supplements, Formulating a diet, Diet and milk product etc. In a later book “Managing High Grade Dairy Cows in the Tropics” (Moran 2012) deals specifically with a major problem encountered by many tropical dairy farmers, namely the poor performance of exotic, high grade (that is high genetic merit) dairy cows when exported from their country of origin to a new, more stressful environment. The challenge with resources on this topic is more of synthesising the amount of relevant material into a format for learning and application by farmers, typically into short courses. Dairy Australia, for example, has recently developed a “Dairy Herd Advanced Nutrition Course” comprising 24 modules delivered over six days together in a classroom and on farm, completed over 15weeks. Two case studies are examples of pluralistic extension with public-private players.

Case study: Smart Farmers, Safe Milk, Green Cows
http://www.snv.org/project/smart-farmers-safe-milk-green-cows

Focus/ Rationale: The project aims to increase dairy farmer livelihoods through a focus on training of new technologies and practices in feeding, animal health and welfare, developing the maize silage market, better ensure uniform quality and regular supply, Improving quality of feed concentrate, improved cow nutrition, improving quality of feed concentrate, and ZeroFly insecticide-incorporated screens to reduce flies.

Target audience: Working together with project partners, the aim is to improve the livelihoods of 400 farmers in the target areas. The intention is to then scale up to other areas of Indonesia.

Service providers: The project is a joint intervention between SNV (a Dutch non-profit organisation), dairy processor Nestle, agricultural company Dupont, and Vesteergard, a company that specialises in pest control solutions, and Kan Jabung a dairy cooperative, collaborating with the Faculty of Animal Science, Bogor Agricultural Institute (IPB).



Project strategy/ Method: The project breadth is consistent with Nestle's three objectives for long-term development; Supply of quality fresh milk, Sustainable farming through cow productivity, and Environmental protection emphasising biogas (see Daranto, 2014). Nestle provides Technical support through a team of Field professionals with relevant operational background in animal husbandry, veterinary sciences, agronomy, delivering a variety of improvement programs aiming at increasing long-term sustainability performance of dairy cooperatives & dairy farmers in the three focus areas. Milk quality interventions include quality based payment (TPC), audits for compliance, annual supplier competition, and sourcing milk cooling equipment. Cow productivity activities include guidance on fodder, silage and rations, animal health such as mastitis, herd records, and a network of dairy farmers comparing cost of production. Environmental activities focus on promotion of biogas, and improvement of cattle sheds.

Case study: DIFS Live Dairy Feed Project
https://www.nederlandwereldwijd.nl/actueel/nieuws/2016/02/03/difs-live-dairy-feed-project

Focus/ Rationale: The Dairy Feed Project is part of the Indonesian Dutch Program on Food Security-Livestock Sectors (DIFS Live). The purpose of the project to improve the dairy cattle feed conditions on small scale dairy farms in West Java. The majority of the dairy farmers in West Java are smallholders each having 1-3 cows. The dairy cattle generally receive insufficient amounts of roughage and concentrates. In addition, these products are often of low or medium quality. Most dairy farmers try to compensate the shortage of roughage with a relatively high use of poor quality concentrates. These poor feeding practices result in low milk production, sub-optimal animal health, relative high cost prices of milk and low farmer incomes. Through improvement of the feed situation, the project's aim is to increase milk production (total milk production and milk production per cow)

and efficiency of milk production (cost price) which should lead to an increase of income from dairy farming.

Target audience: Two small/medium size dairy coops were selected for implementation of the feed pilots namely KPSP Saluyu in Kuningan Regency and KPGS Cikajang in Garut Regency. In each co-op 9 demo farmers were selected from 3 farmer groups for testing and demonstration of innovations.

Service providers: The project is an example of public- private partnership in which public (government, knowledge institutions, coops) and private sector organizations (companies) work closely to achieve the goals of the project. The Netherlands and Indonesian government collaborate in this project through the Netherlands Embassy (funding and supervision) and the Directorate Feed (DAF) of DGLHS of the Ministry of Agricultures (supervision, policy support, local funding) and the Provincial Livestock Office of West Java (facilitation).

Project strategy/ Method: Improvement of fodder supply is implemented by introduction and testing of new forage species, introduction of maize for silage making, fodder conservation of maize, and advice on improved fodder rations. The supply of quality concentrates is facilitated by advice on improvement of feed formulas, improvement of feed mixing facilities and production and testing and demonstration of improved concentrates at farm level. The farmers and staff of the two dairy coops KPSP Saluyu and KPGS Cikajang work closely with the project to implement the feed pilots and provide staff and facilities. Wageningen UR Livestock Research has the overall coordination of the implementation of the project and provides animal nutrition and forage expertise. The interventions are jointly developed and implemented by Livestock Research Institute (WLR) of Wageningen UR, PT Trouw Nutrition Indonesia (part of the Nutreco Group), Royal Barenbrug Group (through its Australian sister company Heritage Seeds) and Ottevanger Milling Engineers. The IPB Faculty for Animal Sciences assists with the implementation of a series of on location fodder trials.

Each of the two coops and each have appointed two feed advisors who are being trained through training of trainer courses (technical and communication and extension techniques) together with the demo farmers. Training of farmers will be implemented by farm advisors and project staff. Initial feedback on the training program is also available on the website. http://www.difslive.com/project-components/dairy-feed/.

Considerations for the ACIAR project

The first SNV/ Nestle case highlights the central role of a manufacturer working with non-for profit and commercial partners, and the coop, to enhance its three objectives relating to supply, production and environment. While, Nestle uses a comprehensive set of interventions to enhance milk quality market built on based mechanisms, and including audits, and competitions, it seems that the main method for information transfer across all three areas is Mentor/consultant but no specific training is apparent.

The DIFS Live Dairy Feed Project is based around the two coops, with strong involvement from commercial feed ad fodder suppliers. In the train-the-trainer short (2 day) course the non-farmer participants included coop staff and government extension staff, with farmer participants being the demonstration farmers. The project had heavy reliance on demonstrations and trials, ie: Technology development extension, supported by courses, ie: Programmed learning, and one-to-one-Mentor/consultant.

Referring back to adoption characteristics of these technical areas it would seem that for nutrition, a combination of programmed learning and one-to-on consultation is an appropriate methodology for skills training and decision support required, with the DIFS project using demonstrations mainly to introduce the idea of milled concentrates and the general practice of concentrate use. For crop related management, demonstrations are probably a more viable method than when used for feeding as crop management is more observable. With such strong reliance on commercial partners, silage management potentially may miss out as commercial partners are likely to more interested in selling seed forage production than managing for silage. Silage and cropping management also lends itself to participatory approaches ie: Facilitation and empowerment model, which appears neither project used.

(ii) Rearing young stock and reproduction management of milking herds

Project context re this technical area

As with many tropical regions, poor reproductive management and high replacement mortality in Indonesia are two issues that could be addressed to improve profitability through changes in farm management. Poor on farm reproduction techniques and husbandry practices are leading to a low proportion of cows lactating, lower herd total milk production potential and higher replacement maintenance costs. Activities will be designed to address these issues and improve calf-rearing techniques.

Adoption characteristics of this technical area

Rearing young stock and reproduction management has a number of interacting elements, and flow on affects which make adoption a lengthy and challenging process. Nutrition is a huge determinant of reproductive performance with nutrition at joining, pre –caving heifer weights, and calf-rearing key areas of focus. In seasonal calving herds in Australia, for example six week in calf rate drops from 77% in liveweights over 540kgs to 49% in cows under 400kg, with the flow increase in late calvers at second calving from10% to 30% of the herd (Dairy Australia,2013), which in turn can affect the timing of calving and feed availability. In addition to nutrition, semen handling, AI technique, and Heat stress are management issues that affect reproduction and which require specific management skills and/or capital to resolve (Moran, 2005).

Complexity in terms of levels of decision is moderate, involving farm subsystem interaction between cows and feeding, but with decision across the life of the herd and impacts on time of calving it involves whole-farm system consideration. Regarding adoption characteristics of this technical area (Rogers, 1983) relative advantage of improved reproduction is difficult to appreciate because of the long lead time and the need to records to be kept, some infrastructure changes may be required hence compatibility is moderate. Trialability of improved nutrition, and observability of improved growth through weight and/or height measurement, is quite high, however semen handling, AI technique, and heat stress management are more specific once-off changes.

Resources available for this technical area

Moran's (2012) latest book "Rearing Young Stock on Tropical Dairy Farms in Asia" is a resource which specifically addresses this area, and covers nutrition of calves, and heifers through to first calving. Dairy Australia's (2013) "A guide to growing more productive heifers: for Heifers-on-Target discussion groups" links nutritional aspects of young stock to production and reproduction issues. Dairy Australia's (2003). "The InCalf bookfor dairy farmers" and DairyNZ (2007) "The InCalf book for New Zealand dairy farmers"

also address both nutritional and mating-related issues covering Calf and heifer management, Body condition and nutrition, Heat detection, Sire selection and AB, Bull management, and Cow health.

Case study: Dairy Australia's In Calf program

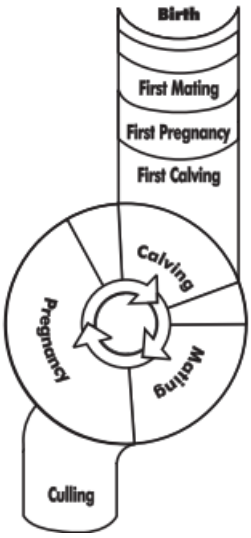
Focus/ Rationale: Although there has been variation between breeds and countries, dairy cow fertility has declined globally since around 1980. Dairy Australia's InCalf Data Project showed that the Australian 6-week in-calf rate decreased by approximately 1% per year over the decade 2000–2010 and while conception rates were a major contributing factor the underlying causes are multi-factorial (Dairy Australia, 2015). InCalf is a Dairy Australia project providing information to better enable dairy farmers to get cows in calf as soon as mating starts. Increased fertility rates helps improve farm profitability. To help farmers improve herd reproductive performance irrespective of their farming system.

Target audience: The primary end user audience is dairyfamers who wish to improve reproductive performance. The intermediate audience is service providers who wish to provide fertility management services to dairyfarmers or otherwise support dairyfarmers in this area.

S*ervice providers*: InCalf provides dairy advisers with a training in the use of the latest InCalf information, resources and tools. And a framework to work with dairy farmer clients. The web site has a list of the advisers who have completed the InCalf Adviser Training Course or the Repro Right course (advanced InCalf Advisers) organised by State.

Project strategy/ Method: The program emphasises a "Fertility for life" approach. The 'fertility for life' cycle involves calf and heifer rearing; first mating, pregnancy and calving; subsequent matings, pregnancies, calvings; and, eventually, culling. Success will require attention throughout the cycle. At each stage of a cow's life, farmers are encouraged to have a management plan in place that answers an important question: "Today, have I done all I can to ensure high reproductive performance?"

The InCalf Book and using The InCalf Tools that focus on the key fertility management areas of: calf and heifer rearing; body condition and nutrition; heat detection; AI technique and sire selection; bull management; cow health; and calving pattern.



InCalf has resources for each of the key management areas: Transition cow management - Springers: repro ready, Bull management - Bulls: power up!, Heifer growth - Heifers on Target, Heat detection - Cows in Colour, Artificial insemination - AI: Do-It-Right

Repro Right is an intensive 10 month professional development program for dairy reproduction advisers to improve their ability to provide intensive problem-solving and whole herd reproductive management services to dairy farmers. The program incorporates a mixture of on-line learning, 3 x 2 day and 1 x 3 day group sessions, assignments and practical tasks on the important elements of reproductive management in Australian dairy systems

Considerations for the ACIAR project

The fact that rearing young stock and reproduction management has a number of interacting elements throughout the life of the dairy herd, as illustrated by the "Fertility for life" concept in Dairy Australia's In Calf program, makes improvement in this area adoption a lengthy and challenging process. The impact of poor reproductive management rests largely with farmers, and the absence of obvious value-chain partners with a stake in the overall success of reproduction issue doesn't help to provide motivation or much support.

There are excellent resources available in this area however the key issue is buy-in and motivation of farmers. In this context, an issue-by-issue approach may be warranted each aiming at showing short-term improvements and benefits. For example, nobody likes to see calf mortalities so separate intervention in this area could focus on avoidance of mortalities in the first instance, and such an approach needs to build on the norms and value of he community. Better feeding of young stock from weaning to calving might seem as bottomless pit of expense hence this again needs to tap into motivational triggers most likely involving participatory group activity ie Facilitation and empowerment model. Participatory group extension in this area can, in fact, be quite enlightening and fun with weighing, measuring and condition scoring animals on different farms. Semen handling and AI technique are areas targeted more at service providers, most likely with instructional learning, however participatory demonstration and sharing could be added in the mix especially if it involved group or action or funding. On the issue of funding, infrastructure to aid heat stress management requires capital to resolve, so extension alone is unlikely to make a difference without funding support.

(iii) Business management

Project context re this technical area

Project documentation indicates that there are various aspects of business management that smallholders can use to make a significant difference to enterprise profitability, which include: communication, access to capital, improved gross margin, understanding costs of production, reduced fixed costs and the influence of family social factors. Morey et al. (2011) notes that 88% of farms have a herd size between 1 and 3 cows and argues, based on modelling, that the most pressing business management issue is to increase enterprise size to 8-10 cows in order for producers to run a full time sustainable business. The project plans to explore the Farmer Business Schools model, and aspects of Moran's (2005, 2009) resources particularly the KPIs.

Adoption characteristics of this technical area

As a discipline, participants typically follow a sequence from learning FBM concepts and knowledge, develop skills, apply those skills to a process, and the process will bring about some sort of change on the farm. In terms of levels of decision making, it gets more complex moving along that sequence. Regarding adoption characteristics of this technical area, relative advantage of FBM training is most apparent when a FBM decision process leads to an improvement on the ground and to subsequent benefit. Because of the sequence of knowledge and skills needed for a new FBM decision process, and a time lag for on-farm benefits, FBM is probably not easily trialable. Documented processes such a planning, and practices, are observable to others, but skills and knowledge are not unless measured by testing. Despite difficulties with poor observability, group discussion and sharing of individual decisions can be beneficial to consolidate FBM kills and processes.

Resources available for this technical area

Farm business management concepts are similar across the world, and the same principles apply across agricultural industries, hence there is an abundance of resources available. Three are mentioned here.

The first set of resources is the business management training initiative by Dairy Australia targeting both service providers and farmers. The initiative provides three types of resources; Management capability and skills training, performance data analysis using an online benchmarking program DairyBase, and business management support tools (Dairy Australia,2015)

The second set of resources is the literature on Farm Business Schools which are relatively light re technical material but detailed re participatory processes (see "Farm Business School: Training of farmers programme South Asia manual" FAO,2011; "Farmer field and farm business schools" FAO, 2014;"Introducing the farm business school: A training package" DAO, 2105; "Facilitation guide for farmer-leaders" by CBSFEDMA, 2015a,and "Farm business school for the Filipino farmer" by CBSFEDMA, 2015b). The business areas explored in these programs, while mostly applicable to dairy, aren't specifically adapted to dairy. FBMs are explored in case two.

The third resource is Moran's book on "Business Management for Tropical Dairy Farmers", and associated papers such "Key Performance Indicators to Diagnose Poor Farm Performance and Profitability of Smallholder Dairy Farmers in Asia" (Moran, 2005) developed specifically for smallholder dairy farms. Of particular interest to the project are the ten key measures of small holder dairy farm performance, and five business efficiency ratios, although his book covers all aspects of business management on dairy farms.

Case: Dairy Australia's Business Management program

Focus/ Rationale: Australian dairy farms face many challenges to profit though better performing dairy farms from across all regions generate the returns that allows for long-term wealth creation. To improve profitability and manage risk, farmers require a range of farm business management skills. The Farm Business Management program will provide tools and programs which focus on maximising profit and managing risk. The target audience is farmers and service providers with a focus on profitability. Objectives are (i) Dairy farmers increase profitability by improved decision making based on appropriate analysis and tools; and (ii) To improve the advisory capability available to farmers to improve decision making

Target audience: The end user target audience is farmers and service providers with a focus on profitability.

Service providers: The intermediate audience is service providers who wish to provide business management services to dairy farmers or otherwise support dairy farmers, particularly in benchmarking.

Project strategy/ Method: re Farm business information the objective is to provide dairy farmers, service providers and industry with good quality farm business management tools that can be effectively used to help dairy farmers respond to challenges and opportunities. Focus in three areas of; Increasing dairy farmer and adviser uptake and use of DairyBase, Integration of DairyBase and Dairy Farm Monitor Project (DFMP), Enhanced analysis and reporting of farm performance data. Tools include Standard Chart of Accounts, Dairy Cash Management Planner.

With regards to farm business management capability, objectives are Dairy farmers increase profitability by improved decision making based on appropriate analysis and tools; and To improve

the advisory capability available to farmers to improve decision making. Four areas of focus are; Development and roll out of farm business management programs (Levels I-III), I Financial Literacy for Dairy Farmers, II Making Sense of Farm Business, III Making Sense of Farm Systems, plus Develop farmer and adviser capability.

Case: Farm Business Schools

Focus/ Rationale: FBS sponsors (FAO, 2014) recognise a need to shift from the traditional focus on improving productivity towards farming as a business, hence farmers need to build entrepreneurship and managerial capacity to be enabled this shift in areas such as; working as small size producer and production for own consumption, way of planning his production, playing small role at the market, practicing of new production and post-harvest operations, seeing himself as part of whole food supply chain with relevant contribution. The farm business school uses a learning-by- doing approach which provides the farmers with a structured experience in which they can learn the theory and practice of farming as a business, implement that learning and then evaluate the progress of their farms and of their own farm business management skills (FAO,2015).

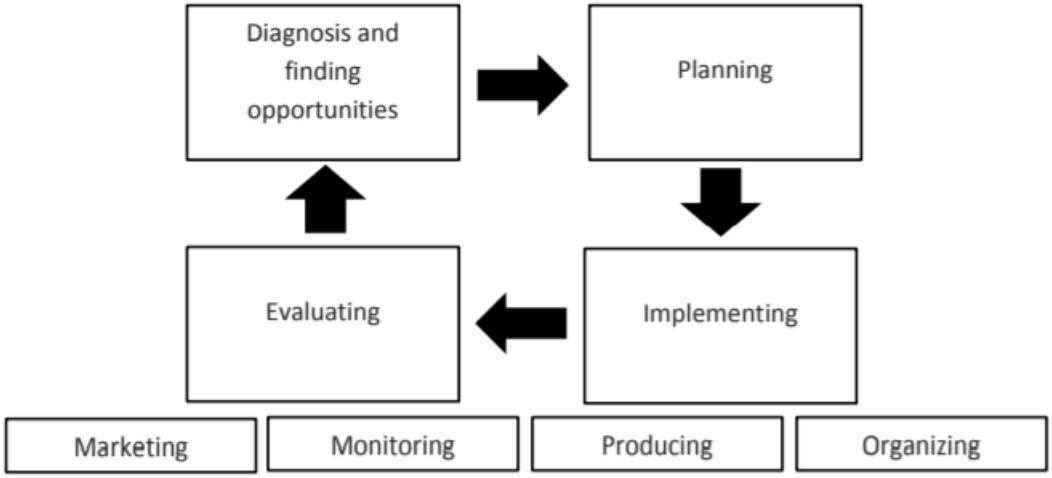
Service providers: Establishment of a core team of trainers is one of the first steps in establishing a FBS, and are responsible for training and guiding leading farmers as facilitators, hence they would ideally have previous experience in farming as a business as well as experience with a farmer-to-farmer approach (FAO, 2014). They can come from government, NGOs and the private sector (FAO, 2015), but also lead farmers who have been trained in the FBS. Key attributes are the ability to work comfortably with farmers, to listen and to be able to adapt to circumstances on the ground, and consideration should also be given to whether male or female facilitators are needed.

Target audience; A Farm Business School brings together a 'group of like-minded farmers' with the aim to develop or strengthen their skills to produce more profitably for the market (CBSFEDMA, 2015a). The Facilitation guide for farmer-leaders (CBSFEDMA, 2015a) emphasises the need to recruit and select participants with a genuine interest in Farm Business management, and commit to working together, listing the following qualities: Genuinely interested in what FBS has to offer, Willing to commit to the FBS program and timetable, Recognize the need to produce for profit and for the market, Currently practicing market and profit-orientated farming or have the potential to do so, Interest in being a facilitator of farmer-to-farmer learning, Experience in farming for profit, and for the market, and with Good communication and interpersonal skills

Project strategy/ Method: The initial part of the strategy is about selecting and training the trainers, and adapting technical materials involving the following steps, as per FAO (2015) (i) Establish a Core Team of Trainers (CTT), (ii) Adapt the training materials, done by the CTT, (iii) Identify, select and train facilitator, (iv) Design and organize the first round of farm-level training (v) Train farmers who have participated in the FBS as facilitators for the next phase. It is suggested that schools are started with 'wo facilitators working together until they gain experience and build confidence. The CTT should mentor and accompany facilitators until they are fully competent and confident. It is recommended that refresher courses and reflection reviews are held at regular intervals so that the facilitators can share experiences and problems and learn from one another.

Key topic areas to be considered include Understanding farming as a business (Profitability and enterprises, Cash flow, Risk and entrepreneurship, negotiation), The current farm business (Analysing

the farm business, Appraising the market, Benchmarking), Planning the farm business (Developing farm business plans), Other topics (More about marketing, Contract farming, Collective and collaborative action, Partnerships among farmers, Group business management, Partnerships along the value chain). Typically the FBS would be conducted over a season, with farmers working through an action learning cycle of: 1) Diagnosing, 2) Planning, 3) Implementing; and 4) Evaluating and Re-planning for each key topic area, seasonal or for the whole year as per the diagram below (CBSEDMAB, 2015). Participants are guided through these processes using a very detailed participant workbook.



Considerations for the ACIAR project

There are some obvious similarities, and key differences between the Dairy Australia FBM and the farm business schools approach. Similarities are that both approaches use a train the trainer model, albeit FBS use farmers. Other similarities are some of the core business management principles and concepts such as analysing and planning, and the sub-topics of margins, finance, costs profits etc.

Some differences are that the FBS places more emphasis on collaboration in business with, collaborative action, partnerships among farmers and along the value chain, which seem to be very relevant to smallholders in the Indonesian value chain. Another key difference is the explicit process-driven nature of the FBS model, whereas such a process might or might be assumed when using dairy Australia tools and resources, and only becomes more apparent in the training courses. Also, Dairy Australia's process tool are typically web and/ or ICT-based, whereas FBS are workbook-based.

Finally, the other apparent difference is the participatory approach in FBS compared to Dairy Australia's FMB program, however when farmers start applying the process in Dairy Australia's courses or using the tools, they become user-driven, and training is typically group-based. To this extent, it would seem mindful to allow participants to choose which elements of farm business management would best help them as a starting point, supplemented by necessary starting level of financial literacy

Further considerations

Scheduling and co-ordination of extension activities

Extension deign, delivery and training related to the fist area of focus, project activity 3.2 "Develop and deliver milk hygiene training for cooperative staff and farmers linked at the milk collection centres (MCC) in West Java" should be separated from the three technical areas of feeding, fertility and business management, because of the separation in the farming system and minimal overlap in service provider/ support stakeholders.

In contrast, extension design support for project activity 3.3 "Pilot and evaluate technical training programs with extension staff and dairy service providers in West Java and North Sumatra" is more complex and is more difficult for two key reasons;

- Firstly, on-farm overlap between the technical areas targeting the same audience means farmers could become swamped with information and activity around topics such as nutrition, fertility, young stock management, and silage making leading to overload of farmers and staff. In this regard the breadth of Farm Business Management, if delivered by the FBS method is likely to identify and act on the other technical areas. Alternatively, FBM could be integrated into other activities.
- Secondly, the deliverable is about training trainers but before that can be done the farmer intervention methodology needs to be decided to provide focus for the training

Hence it will be important to scope, schedule, and co-ordinate activities across topic areas to create synergy and minimise duplication of effort

Training of extension and KUD staff

In their review of training requirements of agriculture extension officers in Iraq, Saleh (2016) defined training for extension officers as the process of acquiring specific skills to perform a job better. They referred to training need as the difference between the required level of individual competence and his present level of competence. Taken together, the need to bridge individual skill gaps, for a specific job, demand a targeted approach to training.

Through analysis of the literature, and experience from authors of this review, it seems that five key dimensions of skill development may be targeted during training, namely:

1. Technical areas of farm management,
2. Leading and managing extension,
3. Extension design and evaluation,
4. Extension delivery and engagement, and
5. Generic extension and interpersonal skills.

Hoque & Usami (2008) also raised the issue of follow up support after training, and found it to be context-specific. In their Bangladesh study, extension officers had difficulty understanding training on group dynamics and supervision was important to refine skills on working with groups, while further discussion with skilled extension workers was an important contributing factor towards improving planning skills. In contrast, skills on organizing and running demonstration or assessing farmers' problems could be refined simply with post-training practice.

Information and Communication Technologies

Information and Communication Technologies (ICTs) are increasingly being used to support agricultural extension, and increasingly mentioned in the agriculture extension globally (eg Bell, 2015; Vignare, 2013) and Indonesian-specific contexts (eg Purnomo & Lee, 2010). ICT include radio, multimedia broadcast (TV, video), basic mobile phones for text and voice, smart phones and devices, computers and the internet (Bell, 2015).

Bell (2015) makes the point that ICT can be used in a range of forms to support different extension functions, and the best use will likely involve integration across a range of options combined with traditional approaches. To this end he provides a matrix highlighting the most promising use of specific ICTs for various extension situations ranging from linking farmers to markets, raising general awareness of opportunities, providing technical information, diagnosing problems and recommending a solution, assisting with business planning, conducting and responding to farmer feedback. Among this matrix, not surprisingly, one-way ICTs feature for awareness and information broadcast, whereas phones are sited to personalised two-way interaction, while computers and smart phones with internet contain features of both. A natural extension of this matrix approach is recognition that one-way ICT such as radio is not suited to complex and complicated extension messages, as noted by Baig and Aldosari (2013).

Vignare (2013) notes that best fit for ICT in extension and advisory services is difficult to summarize because the system has so many participants, and each player within the system requires different ICT options. Hence the use of ICT requires assessment of the role it might play in the extension campaign taking into account the specific players involved.

The use of ICT is not without barriers, which Purnomo and Lee (2010) examined in Indonesian context. They studied the readiness and barriers towards ICT programme implementation: perceptions of agricultural extension officers and, through factor analysis, derived four main variables describing readiness and barriers to ICT. In support of ICT use, results showed that personal readiness, management readiness, and infrastructure readiness towards ICT was positive, whilst individual and policy barriers were low. Working against ICT, farmer readiness was considered to be low, and organisational culture and technology barriers were high. For example, whilst 52% of Indonesian extension workers were found to have access to a computer in the Yogyakarta province in 2013, only 34% had internet in their office (Agunga & Putra, 2015).

Regarding farmer use of ICT, Hariadi (2012) makes the point that whilst computer–based communication may be less attractive to farmers due to cost, time, and language barriers, telephone and cell phone may be more attractive ICT options. Lubis (2010) reported that 85% of vegetable growers in West and South Java owned a cell phone which they use as a telephone, to text, take photos, and access radio, and for information sharing cyber-extension. Since that time, when 75% of the general population owned a cell phone (Lubis, 2010), 91% of Indonesians now own a cell phone, more than 50% have a smart phone (47%) or tablet (5%), and 21% own a computer (Medionovianto, 2017) making ICT increasingly available.

Extension reach and change targets

Much of the preceding review has focussed on extension methodologies to achieve change, however it needs to be recognised that the project also has ambitious reach targets for this change; *"The overall goal of this project is to contribute to increasing milk supply (quantity and quality) by 25% by 2020 for at least 3,000 dairy producers in the geographic locations of West Java and North Sumatra".*

Project documentation states that several KUDS each with 7000+ farmers will be primary partners in the pilot phase of Activity 3.3 *"Pilot and evaluate technical training programs with extension staff and dairy service providers in West Java and North Sumatra"*

Taking into account problem context and characteristics of the topic areas, milk hygiene and mastitis stands out as an area where both participation and adoption should be high as it is not complex and has a clear benefit for farmers if price signals reward better quality. Whist nutrition is more complex, requiring a theoretical understanding to inform decisions which change seasonally and stage of lactation, needs and benefits in terms of production are clear hence participation demand should be reasonably high and adoption to least moderate. Silage management is more straightforward, but may not suit everyone hence participation demand could be low but adoption moderate. Reproduction management in contrast to milk quality and feeding, has less immediate or obvious benefits therefore seems less likely to be in demand or adopted. Taken together their appears larger project benefits towards milk quantity and quantity, and higher likelihood of success, in areas of milk hygiene and feeding compared to reproduction and farm business management which may influence scheduling priorities.

Other considerations

Based on considerations explored within this review, some guiding principles emerge;

- The identification of the problem context in terms of farm practice is a clear starting point for each of the interventions.
- Identification of service providers and support personal with skills and/ or a stake in the area of focus provide the basis for the delivery support team.
- Adoption characteristics, and content of the information resources help to inform the skills required to deliver, and associated training and extension approaches.

These three elements need to be integrated into the design phase to plan how each method in the extension strategy complements the other, including train-the- trainer activities, creating the platform for scheduling, delivery, and review/evaluation of interventions.

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