Agricultural Systems 135 (2015) 66–76

Contents lists available at ScienceDirect

Agricultural Systems

journal homepage: www.elsevier.com/locate/agsy

Leverages for on-farm innovation from farm typologies? An illustration for family-based dairy farms in north-west Michoacán, Mexico

José Cortez-Arriola [a], Walter A.H. Rossing [a,*], Ricardo D. Améndola Massiotti [b], Johannes M.S. Scholberg [a], Jeroen C.J. Groot [a], Pablo Tittonell [a]

[a] Farming Systems Ecology Group, Wageningen University, P.O. Box 430, 6700 AK Wageningen, The Netherlands
[b] Graduate Program in Animal Science, Chapingo University, Km. 38.5 Carretera México-Texcoco, Texcoco C.P. 56230, Estado de México, Mexico

ARTICLE INFO

Article history:
Received 6 October 2012
Received in revised form 3 December 2014
Accepted 17 December 2014
Available online

Keywords:
Multivariate analysis
Farm typology
Economic analysis
External dependency
Farm yield gaps
Farm profitability

ABSTRACT

Knowledge on farm diversity provides insight into differences among farms, enables scaling from individual farm to farm population level and vice versa, and has been used in the definition of recommendation domains for introduction of novel technologies. Farm diversity can be broadly described in terms of resource endowment and resource use strategy, or in other words, in terms of scale and intensity of production. Measuring intensity of production requires much greater monitoring effort than measuring scale of production, and often only proxies of production intensity are used. Using data from a regional farm survey and from intensive on-farm monitoring the question addressed in this paper is to which extent results of farm surveys that measure primarily scale of production can inform on-farm interventions aimed at improving farm performance. The survey included a random sample of 97 out of 664 smallholder dairy farmers in a community in north-west Michoacán, Mexico. Farm types were identified by a combination of Principal Component Analysis to reduce the dimensionality of the dataset, followed by Cluster Analysis. The survey was complemented with detailed analyses of costs, revenues and productivity on 6 farms over the course of one year. Survey results revealed considerable variation among the dairy farms in land area, livestock units, amount of hired labour, and infrastructure and equipment, which led to the distinction of 4 farm types. Indicators for animal health management and feeding strategies were uniform across the 4 types. The farm types matched the distinction of family-based and semi-intensive farm types used in Mexico. The detailed analyses of the individual farms belonging to the different types, however, revealed differences in resource use strategies reflected in differences in animal productivity, labour productivity and return to labour. Differences in animal productivity and labour productivity were explained by stocking rate, albeit in different ways. Return to labour was strongly related to cost of feed. Profitability was negative for all farms and was on most farms related to high external feedstuff costs, which constituted 59–89% of the feed cost of the animal ration. The results indicate that in addition to variables reflecting resource endowment or scale of production, typologies that aim to inform on-farm interventions need to consider farm characteristics that reflect intensity of production. Which variables should be selected will need to be determined in a preliminary assessment. To enhance internal resource use efficiency as was the purpose in the current study, candidate variables expressing intensity could include the share of external feed in the ration and proxies of internal resource use, e.g. reflected in crop and milk yields. Opportunities for on-farm innovation arising from the analyses are discussed from the perspective of labour flexibility, low costs and use of internal resources.

1. Introduction

Despite being the largest economy of Latin America after Brazil, Mexico is among the largest importers of dairy products in the world, particularly powder milk. Annual imports over the past 30 years increased by about 0.05 Mton annually and achieved values of approximately 3 Mton in the first years of this century, equivalent to over 20% of national milk demand (FAO, 2011 in Wattiaux et al., 2012). In Mexico milk is produced on about 150,000 farms (SAGARPA, 2011), 83% of which are family-based. Milk production, ranking third in value of domestic agricultural products, increased substantially after the year 2000 due to increases in numbers of cows. Average cow productivity has been estimated as 4000–5000 kg milk per cow per year, and remained unchanged for the last 25 years (Amendola,

* Corresponding author. Tel.: +31 317 481201; fax: +31 317 481203.
E-mail address: walter.rossing@wur.nl (W.A.H. Rossing).

http://dx.doi.org/10.1016/j.agsy.2014.12.005
0308-521X/

2002; Wattiaux et al., 2012). From the mid 1960s to early 1990s the Mexican government implemented a number of policies aimed at reducing the dependence on imported agricultural commodities, supporting farmers through subsidies and funding schemes (e.g. CONASUPO, established in 1965) (OECD, 2006). Trade liberalization triggered by Mexico joining the North American Free Trade Agreement (NAFTA) since 1994 resulted in withdrawal of governmental support to family farmers and considerable drop in prices of agricultural commodities. Despite direct income support programs such as PROCAMPO, government expenditure on rural communities has been decreasing and the chronic erosion of rural livelihoods and lack of local employment opportunities are important causes of the high rates of rural emigration (Villareal and Hamilton, 2012). Mexico has the largest and longest sustained international flow of migrants worldwide, most of which go to the United States (Hunter et al., 2013). This poses a serious threat to rural and agricultural development and to national food security.

In Mexico four types of dairy production systems are commonly distinguished: specialized, semi-specialized, family-based, and dual purpose, comprising 17, 15, 8, and 60% of the dairy farms and 50, 21, 9, and 20% of production, respectively. Dual purpose systems produce milk and meat, and are usually run by the farm family. They are particularly found in the tropical and subtropical zones, and are marked by low productivity, pasture-based feeding and strong seasonal fluctuations. Specialized systems use high levels of external inputs and intensive management practices, have hundreds to thousands of dairy cattle which are fed in feedlots, and are often part of larger business conglomerates that comprise several parts of the value chain. The distinction between the categories semi-specialized and family-based farms is fairly recent (Amendola, 2002), and aimed to accommodate the large diversity among those farms in temperate regions where the family provides all or an important part of the labour. These farms range from subsistence to sharing attributes with specialized systems. Semi-specialized and family-based farms are particularly located in the west central highlands, which include the states of Jalisco, Aguascalientes, México and Michoacán.

Farm typologies have attracted attention of agricultural scientists as a means to distinguish patterns in populations of farms. Using "farm typology" as topic search term on the Web of Science resulted in 54 publications since 1984, 48 of which were published after the year 2000. Pacini et al. (2014) consider understanding farm diversity in its multiple dimensions decisive in the design of agricultural policies and in assessing suitability of technological innovation. When considering farm diversity, a broad distinction can be made between scale of production and the intensity of production (Van der Ploeg, 2003). Scale of production relates to resource endowment, e.g. amounts of land, capital and labour; intensity of production refers to production per hectare or per animal. A qualitative review of the literature suggests that farm typologies have been constructed to identify diversity per se and its underlying causes (e.g. Gaspar et al., 2008; Tittonell et al., 2005), to scale from individual farms to the farm population (often regional) level and vice versa (e.g. Righi et al., 2011), and to define recommendation or response domains for introduction of specific novel technologies (Franke et al., 2014) or policies (e.g. Andersen et al., 2007). For these purposes, focus is on finding patterns in variables that express resource endowment along with proxies for intensity of production, particularly when studies focused on less developed countries where farm management data are scarce. Such typologies, however, may not be useful to identify opportunities for on-farm innovation when technologies are not pre-defined but the aim is to mobilize a customized mix of technologies to address key weaknesses in farm performance.

From 2007 to 2010 a project was carried out, aimed at improving farm-level productivity as one of the means to reverse marginalization of Mexican family-based dairy farmers. The project focused on an area in the north-west of Michoacán where dairy farming was the main agricultural activity. Visits and pre-analytical research by the Autonomous University of Chapingo had raised interest among the local farmers for a development-oriented study in which existing productivity-improving technologies would be introduced to farms that showed promise to benefit from the interventions. The first phase of the project consisted of an assessment of farm diversity as a precursor to engagement in on-farm innovation. While data on resource endowment of the dairy farms in the region could be collected relatively easily through surveys, establishing intensity of production of family-based dairy farms required time-intensive monitoring of milk production and grassland and herd management as farmers had no tradition of keeping records.

Using data from a regional farm survey and from intensive on-farm monitoring the question addressed in this paper is to which extent results of farm surveys that measure primarily scale of production can inform on-farm interventions aimed at improving farm performance.

2. Material and methods

2.1. Case study region

The municipality of Marcos Castellanos is located in the north-west of Michoacán State, Mexico (19° N and 103° W) at altitudes between 1500 and 2400 m above sea level. Climate is temperate with a rainy season between June and October, and rainfall and temperature averages of 798 mm and 18.9 °C, respectively. Vertisols, luvisols, and litosols are the main soil types in the region (SEMARNAT, 2003), arranged on hills with gentle slopes with intermittent ravines and small nearly flat areas. The original vegetation types include mostly thorny and broadleaf forests. The area of the municipality is 233 km^2, of which 86% is rangeland and 12% is cropland, which is used mostly for forage maize production.

Livestock activities dominate the agricultural landscapes of north-west Michoacán State since the introduction by the Spanish colonizers of cattle, sheep and pigs in 1545 (González, 1992). The development of road networks in rural areas coupled with increasing human populations in nearby urban centres favoured the establishment of an important dairy sector towards the end of the nineteenth century. Despite soil constraints and strong seasonality of rainfall, Michoacán accounts for 3.2% of the national milk production and is ranked as the 12th largest milk producing state (SAGARPA, 2011). Since 2000, the volume of milk produced in Michioacán increased by 1.2% annually, but productivity per animal remained constant. Although the area of Marcos Castellanos only accounts for 0.39% of Michoacán, the municipality is the largest milk producer and supplies 11% of the state's production (SAGARPA, 2012). Livestock production and dairy industry are the main economic activities in the region. Farms sell their milk either directly to large dairy processors or through local cooperatives. Various breeds of cattle are used, with a predominance of Holstein Friesian and Jersey, often as crosses with Zebu or Brown Swiss. Cows are mostly grazed on rangeland, which is sometimes improved with high production grass species and only occasionally replaced by sown pastures. Farmers buy concentrates as a baseline feed strategy and to overcome periods of low forage production. Most farmers grow some maize for feed, often by continuous cropping of hybrid maize varieties with inputs of herbicides and NPK fertilizers. Producing silage requires a higher level of mechanization and knowledge than available on small farms, but contractors facilitate adoption in the region. Traditionally, maize is conserved as ground maize obtained by grinding field-dried entire maize plants into pieces smaller than 5 cm length. Ground maize is considered to be a low-cost alternative to ensiling maize.